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Science Education

SPECIAL ISSUE ON ELEMENTARY SCIENCE*

SCIENCE IN THE CURRICULUM OF THE ELEMENTARY SCHOOL †

HELEN HEFFERNAN
Chief, Division of Elementary Education, California State Department of Education

The modern curriculum finds its orientation in the nature and needs of children living in a democratic society. The integrative themes around which the elementary school program is organized provide for the enrichment of the experiences which the child has in his immediate environment. On the basis of his acquaintance with the physical and social world of which he is a part, the child's understanding is gradually extended by experiences which help him to contrast and compare his known culture with the primitive and pioneer cultures from which it evolved. He sees man engaged in the simple manipulative activities by which he has been able to make his environment satisfy his basic human needs.

What has been the factor responsible for the transition from primitive or pioneer society to the life the child knows? How has man traversed the long road from the piki bread of the Hopi Indian to the wrapped, vitamin-enriched, delicious loaf the child purchases at the corner grocery? It is platitudinous to say that science and technology are responsible for our modern culture and that the problems which perplex the world are due to the lag between scientific progress and man's social arrangements. In the elementary school, even the young child needs understanding, consonant to be sure with his level of maturity, of the ways in which man has utilized scientific and mechanical techniques in satisfying his needs. Intelligent participation in our culture is predicated upon an understanding of its scientific bases. The lag between scientific advancement and social adjustment can be decreased only as understanding develops concerning the need for the application of a dynamic social theory, and the scientific method to the institutions of social life. Even young children can understand that science itself is oblivious to human values. In the world in which they live science is being employed simultaneously for the advancement and for the destruction of humanity. But the social significance of science becomes apparent to children when they study it in relation to such areas of experience as transportation, communication, and conservation of natural resources or community health. The teacher in the elementary school has the opportunity to build early those emotionalized outcomes of experience which we call attitudes in regard to science. The social values of science serving the steady progress of society is not beyond the understanding of elementary school children.

The elementary school has had one significant ally and one formidable opponent in the work of helping children to develop

* See note page 210.

† Paper presented at the Twenty-third Annual Meeting of the National Council on Elementary Science, Hotel Empire, San Francisco, February 21, 1942.

fundamental scientific concepts essential to a constructive understanding of our contemporary culture. The ally has been the children's inherent interest in the physical and biological aspects of their environment. The interest of children in the materials of science is so apparent that the elaborate evidence on the subject produced by research students seems almost to be another case of belaboring the obvious.

No teacher who has received from the hands of a child a tightly clutched bouquet of brightly colored flowers, or who has shared his excitement when he discovers the community life of an ant's nest, or who has watched a group of boys at the "young Injun" stage successfully repeat the experiments of the immortal Marconi, needs any statistics to reinforce the validity of her firsthand experiences. No experiences are more genuine to a child than those he has with the moving, living, tangible world of which he is a part. Fortunate, indeed, is he if he is sharing these experiences with a teacher whose background is such that she can guide his observations into richer and more satisfying understanding. Through these beginnings, a child can be led into a realization of his responsibilities for the intelligent use of his own life and the resources of his environment; through them he may develop deep and permanent interests for his present and his adult life.

The denial of the opportunity which every child should have to develop basic scientific concepts and attitudes lies in the inadequacy of the preparation of teachers to give children guidance in science experiences. This inadequacy manifests itself in two important ways. In the first place, the teacher may not have had sufficient education in science to answer the children's questions relative to their environment or to guide them to satisfactory sources of information; and, in the second place, she may fail to see the science experiences implicit in the major curriculum units and without which children can gain no thorough or comprehensive understanding of the specific unit under consideration.

In the former situation, the child soon ceases to consult a sterile source and unless he receives stimulation and guidance from an agency outside the school, his interests are likely to be diverted to other fields which the teacher apparently considers more valuable. In the latter situation, incomplete understanding of an area of experience studied is a disintegrating influence. A child cannot experience feelings of satisfaction in regard to his study of aeronautics unless he knows something of the physical principles which make flight possible; his study of communication will be inadequate unless he knows something about sound, how it travels, in which materials it travels fastest, how we hear sound, what makes different tones, as well as something of the operation of the telegraph, the telephone, and the radio; his understanding of the life cycle and habits of the pine beetle will result in a more intelligent attitude toward the problem of conservation.

The importance of adequate teacher education in the field of science is apparent. The teacher must have the background which makes her see the importance of providing significant experiences through which the child comes to understand his world. She must have sound knowledge of science concepts, materials, and methods. Children are eager for adventures in the field of science, but most of our teachers have not had the necessary science education to point the road to these adventures. The greatest problem in giving science its proper place in the elementary school curriculum lies in the limited training of teachers.

Here we are confronted with a vicious circle. School administrators are reluctant to emphasize science in the elementary school program because of the status of

teacher preparation. They are uncertain concerning the teacher's success in handling it. Institutions for teacher education are reluctant to provide sufficient training in science because they do not believe it occupies an important place in the elementary school program as judged by printed courses of study. The only way out of the dilemma seems to be for school administrators, who see the importance of science in the education of children, to make provision for inclusion of science in the program and to provide the necessary in-service training, books, visual aids, and other materials of instruction in sufficient quantity to put the program into operation. When a large number of school systems move in this direction, the teacher-education institutions which maintain that they must prepare teachers for schools as they are will begin to include adequate science instruction. Not until then will we begin to find the emphasis on science in the elementary school approximating the importance of science in the modern world.

The past decade has witnessed a great stimulation to the teaching of science because of the appearance of a large number of textbooks in elementary science by competent authorities. While these materials are valuable, they have the danger of making science another bookish subject in the curriculum. Unless the books are used to extend information gained from firsthand observation and experiences, teaching will not result in the development of scientific attitudes. It is a violation of the scientific method itself if the children's experiences in this field become a process of handing back to the teacher in oral statement information obtained from a printed page. The acquisition of generalizations should result from many experiences. They become mere verbalism unless they result from many experiences which a child can relate meaningfully to his past experiences.

Those most interested in the extension of science education are making no plea for the introduction of science as "another subject" in the elementary school curriculum. Rather do they recognize science as a necessary and integral part of all social situations. Specialists in the field of science are frequently unaware of the progress which has been made in recent years in how children learn. Young children do not analyze their experiences into specialized types of subject matter. They draw from any field in order to understand their environment or solve a problem. Subject-matter boundaries are coming to have much less significance in the curriculum of the elementary school. Attention is centered on worth-while experiences rather than discrete aspects of experience. The problem of selection of specific content in science is solved when science is used to deepen meanings in relation to the child's study of community life, boats and cargoes, life studies of culture, aeronautics, communication, the story of petroleum, or how man satisfies his need for food.

Social studies devoid of science implications are incomplete. Science removed from its setting of social meaning is likely to become a series of unrelated bits of subject matter or poorly comprehended generalizations. Understanding and appreciation of relationships are more important in fact than discrete learnings in any single field. Science has its place along with history, geography, industrial arts as a source of knowledge to help in the solution of problems of significance in living. Such a point of view must not be interpreted to mean incidental teaching of science. On the contrary, it means that every area of human experience worthy of exploration by children shall be thoroughly studied by curriculum specialists and experts in the field of science. Teachers of limited science training cannot be expected to discover this related content for themselves or become aware of its importance.

In this period of transition in the functional education of teachers, the supervisors

of instruction qualified in science or the special teacher of science should operate in terms of this general principle of relating science to the major areas of experience in which the curriculum is organized. Such service is needed now to provide authentic material in science related to areas of experience. The specialist in a field as complex and extensive as science will probably always be needed if the possibilities of science understandings inherent in the experience curriculum of the modern school are to be realized. Just as art and music occupy an increasingly larger place in the modern school because their values in building social understanding are coming to be recognized, so science will occupy its rightful place when it gets out of the "special subject" category and becomes an indispensable means of extending and enriching social meanings.

To build a proper and continuous program of education for the establishment of scientific concepts and attitudes demands the solution of many important problems in the field of methods, materials, and teacher education. The outcomes of early education in the field of science cannot be measured by an increasing number of scientists and naturalists in our population, but rather in terms of an increasing number of competent persons who can interpret the contribution science has to make to health, safety, and the welfare of human beings and who have acquired some of the methods used by creative workers in the field of science in making a constructive attack on the problems of social living.

THE FUNCTIONS AND USE OF EXPERIMENTS IN ELEMENTARY SCHOOL SCIENCE *

VESTA HOLT

Professor of Biological Science, Chico State College, Chico, California

Why should science be taught in the elementary school? The teacher must have the answer to this question clearly in mind before proceeding with plans for a science unit. One objective is to open new avenues of interest and satisfaction. Another is to acquaint the child with valuable scientific knowledge and its use. A more important function than either of these is to develop broader concepts and outlooks regarding the problems of living. But the most important objective, perhaps, is to cultivate in the future citizen scientific attitudes and methods of procedure in all of his thinking.

A scientific attitude is the outgrowth of experience in using the scientific method in the solution of problems. It is a reverence for accuracy of observation, of record, of thought; an appreciation of proof in the search for truth; a recognition of the importance of suspended judgment and the open mind. If we accept this objective as our major goal, the emphasis of our teaching will be more on method than on subject matter. It can not be attained by studying science from books or by passively accepting what the teacher says. A functional scientific attitude will result only from the actual participation of the child in each phase of solving a problem. Two techniques are of preeminent importance; observation of nature and controlled observation or experiment.

Experiments planned and executed by the teacher as a class demonstration are of little or no value in the attainment of this

* Paper presented at the Twenty-third Annual Meeting of the National Council on Elementary Science, Hotel Empire, San Francisco, February 21, 1942.

objective. They may serve other functions such as stimulating interest or illustrating a point the teacher wishes to emphasize. But to expect a child to develop scientific attitudes by being told that he should is like trying to train aviators on the ground. The child acquires scientific attitudes by using them in the solution of problems, The function of the teacher is to direct and aid rather than to give the child vicarious experience. Often one will hear, "Now, children, I am going to show you what happens when heavy rain falls on sloping soil. You have read about soil erosion. Let us see how it actually works. In this box I have soil. In the second I have sod. I will pour water from the pitcher on each box while it is tilted and we will put this pail underneath to catch the water. Now watch what happens. . . . What conclusions would you draw about the value of a soil cover?" The whole exhibition reminds me of a float I saw in a parade on which a gowned professor was pouring "knowledge" from a pitcher into the mouth of a jackass. How much greater was the value received by a class in a lumber district near Chico! The children had been studying forest conservation. A boy on his way to school noted soil erosion in a road cut and brought up the question, "Aren't there other things we should not waste, for instance, soil?" That led to a discussion involving stories of the tragic results of soil erosion which the children had read or heard about. The teacher brought the discussion back to the local environment. Observation following the discussion led to the discovery of a deserted mine-digging which had been the beginning of a gully that now had cut back into the school grounds. An immediate and vital problem of saving their playground faced the children. They read all they could find on the subject. They investigated how the U. S. Soil Conservation Service handled gullies and they planned their campaign. They built a series of dams in the gully using a different type of material in each. The slope of one dam was wrong. The teacher said nothing. The first rain came and part of that dam went out as they watched. They saw the reason and corrected it. These children recognized their problem, marshalled their resources, executed their experiment, and observed their results. They developed confidence in their own ability to face and solve problems, they learned the value of available knowledge related to their problem, and they will always appreciate the problems of soil erosion as few people do.

I do not want to be misunderstood (as I am too frequently) when I say that in order to attain the prime goal of science education in the elementary school, experiments should arise from the child's questions, and should be child-planned and executed. I mean just that, but I do not mean that they should follow every child whim without consideration of the subject in hand, expediency, or value of results. The teacher maintains the guiding hand but he should not put on the show. It is his job to see that the child is engaged in worthwhile activity and that he does not blow up the school house.

In order that the child shall get the most from his experimental work, the procedure should be somewhat as follows:

Problem: This is one of the most important steps in the whole process of teaching by experimentation. It arises from a need felt by the child, a question which requires an answer. The question must be clearly stated and stripped of its irrelevant attachments.

Background: What do the children know already from their own experience and reading which may help in answering this question? What can be found out by observation?

Plan: What can be done which will help answer the question? An experiment or experiments should be carefully planned *by the children.* Hopelessly impractical

suggestions may be ruled out by group discussion. The teacher may supply some needed technical aid and make occasional suggestions but he must be very careful not to dominate the situation or inhibit thought. Often one learns as much from experiments which do not work as from successes.

Procedure: Once the experiment is carefully planned, it may be executed either by an individual, by small groups or by the entire class. Care in developing accuracy in technique is important.

Results: What happens in the experiment must be observed accurately, and judged carefully by all who are concerned with finding an answer to the question.

Conclusions: What did the experiment show that helps to answer the question? Is the answer complete? If not, will further experiment help? If not, can references be found which will give reliable information pertinent to the problem?

Some examples from actual schoolroom experiences may clarify this procedure.

A fifth grade class in The Dalles, Oregon, had been working on the general subject of nutrition. The immediate problem was on the digestion of foods. They had proved that saliva digested starch and then the question was asked, "How long must we chew food for digestion to take place?"

"How can we find out?" asked the teacher.

"Try it," was the immediate response.

"How shall we do it?" was the teacher's next question. The discussion led to a review of different types of foods, methods of testing for them, and information regarding the process of digestion. With this background in mind the children worked out the plans for an experiment.

John suggested, "I think we should put a bit of cooked potato into a test tube with some saliva and test it every little while for sugar."

Rose objected, "I think the potato should be chewed. This is what we do. It mixes the saliva in well and besides digestion goes on in the mouth at the temperature of the body."

Her view prevailed. A discussion of the length of time which might be needed led to starting the experiment with a chewing period of ten seconds.

Rose was chosen to chew bits of potato. Frank held a watch. Mary and Laura, at a table, with Fehling's solution and an alcohol lamp, stood ready to test for sugar.

Rose bit and chewed. No smiles; not a sound. "Ten seconds," said Frank. Rose spat into a test tube. Mary and Laura poured in Fehling's solution and applied the flame. Soon the blue liquid boiled but there was no sign of precipitate. Guiseppe was appointed to hold the tube.

Another bite and another chewing. "Twenty seconds," said Frank, and again a negative result.

A third bite. "Thirty seconds." And now Mary thought she saw a trace of changing color. A fourth. Down came the characteristic red in quantities that could be seen by everyone.

Guiseppe announced, "We got it sure in forty seconds," which meant to him, and to the whole class, that under the conditions of the experiment, the digestion of potato starch was begun forty seconds at the latest after the potato entered the mouth.

A question had been asked, an experiment had been devised for its solution, and an answer had been obtained.

From the first grade at our College Elementary School comes the following incident.

The children had been given some wheat when they visited a farm. They had planted it and observed its germination and early growth.

"How do we know it is growing?" asked a child after the rate of growth became less evident.

"How can we find out?" asked the teacher.

This required some thinking for these children had not used rulers. Finally a child suggested that they could stand a stick beside a plant putting a mark where it was today. Tomorrow they could see if it had passed the mark. This procedure gave them their answer but there was difficulty in telling how much it had grown. The teacher showed them a ruler with marks at regular intervals and they decided to use it. This led into the use of the ruler in measurement.

An experiment with social implications comes from a rural school in Nevada County.

Do birds eat what is good for them? This question arose in a primary room in connection with the hot lunch. Some children had not eaten their lunches well and this question about the birds was raised as they watched the California woodpeckers and juncos outside the window. What do these birds eat?

The first day they watched both woodpeckers and juncos eating crumbs from the black walnuts the boys had cracked near a corner of the schoolyard. The next day graham biscuit crumbs were scattered in the same place. Although the woodpeckers flew down and investigated the new food they apparently let it alone while the juncos feasted. Next some apples were tried and both birds ate some. But the apples brought the bluebirds who enjoyed them.

Out of these observations and experiments the children are interested in learning what is the right kind of food for them to eat.

The nature of experiments which may be done successfully by children depends on the development of the child and the character of the question under discussion. It may be very simple involving nothing more than holding up a handkerchief to determine the direction of the wind or it may involve several days of planning, looking up references and collecting materials and equipment. A large amount of equipment is not desirable. Makeshift equipment which the children construct often teaches them more than better equipment which gives perfect results. The child may lose sight of the question to be solved in attempting to understand a mechanism which is outside his range of experience. On the other hand, the contraption he has constructed offers no mystery.

This emphasis on the child-planned and child-executed experiment does not relieve the teacher of the responsibility of having ideas of usable experiments on reserve. In fact it demands a thorough understanding of the problems which may arise and the possible approaches for their solution. He must recognize essentials and know how to meet emergencies. Ready-made, copy-book experiments will not suffice. Versatility is of prime importance. While the teacher needs to be a reservoir of information and reliability, he must learn to use his resources in the most effective way. He asks questions which lead the child toward the solution of the problem in hand. For example, "After Virginia's first day of science, her mother said to her, 'I suppose Mrs. Brodie told you lots about animals today.' 'She didn't tell us a thing,' Virginia replied, 'she just asked questions.'" Questions skillfully asked lead the child to think carefully, to solve his own problems, thereby building up a confidence in his own ability and resourcefulness. The place of the teacher in this type of teaching is well described in the following quotation from a letter I received recently from a teacher.

When I begin my preliminary organization of a unit or area in science I always consider the ways by which I can arouse the curiosity of my students so that they will suggest problems they would like to solve. A science teacher must be careful that he gives his students an opportunity to behave scientifically. It seems to me that the first evidence of scientific behavior is an expression of curiosity. For that reason I try never to predetermine what problems need to be developed by the students. I may have in mind a great variety of problems that would be usable but wouldn't it be a violation of our very aims if I said, "Here are some problems. Now lets analyze them and begin our research work"? Some of the thrill in science should be the finding of problems and the analysis of those problems as well as the procedure of research that follows. Getting children to develop their own problems out of their own curiosity is not difficult except among those who have experienced nothing but the receipt of hand-outs from their teachers. Fortunately, I think teachers in general are beginning to see this point and they are avoiding this "hand out the problem" type of teaching.

As an example of how problems may be developed I can tell you of a unit in the area of Health that is "growing up" in my science classes at the present time. The unit will probably be called "Modern Health Problems." After some discussion on health, disease, the body, using animals for dissection, and a dozen other topics, many of the students began asking questions which would be suitable for problems. I recorded all of their questions and from them we began to boil down the questions by doing away with duplications and combining others. Finally we were able to agree on four or five major problems that we would like to do research on. One of these was, *To Find Out How Alcohol, Tobacco, and Drugs Affect the Body.* We have decided that there are some opportunities for experiment and some students have written down such questions as these to be used in experiments:

Experiment 1. Will tobacco leaves kill small animals.

Experiment 2. What will happen to white mice if pieces of tobacco are placed in their food?

I like my students to develop the idea that an experiment is a search for the truth about something; that the results of an experiment should provide a bit of knowledge that ties in with some bigger problem to be solved. Sooner or later they should see the experiment is one of many ways of gathering information. We do a lot of experiments in each of our units. Before we have ever concluded a unit we make sure that every experiment or other research activity has contributed some fact or truth to one of the problems of the unit. At times in a group discussion we check over the various experiments then in progress asking whether or not they will contribute something to the problem in hand. Isn't this evaluation important?

This type of teaching makes certain demands of the teacher. He must have scientific attitudes regarding all questions. He must use the scientific method in his approach to his own problems. Scientific thinking must permeate his very being if he is to lead children to think scientifically. Our effort will not be in vain if we are building that John Jones, Kinsey so aptly describes.

"Do we, at heart, want John Jones to grow into a man who is not dependent on newspaper science, or the biology of a silver-tongued statesman? Do we want him to have some better reason than the school book command for cleaning his teeth, choosing a balanced diet, and making a profitable distribution of work, rest, and play? Do we hope he will become the sort of man who believes neither in complete depravity of all politicians nor the unimpeachable altruism of his political candidates; whose acceptance of established biology will lead him to having his children vaccinated and who will submit himself to vaccination; who is cautious of the gossip which makes social small-talk, but who treasures the verities of observed data as against fashion, creed, convenience, and cult; whose respect for observed truth will extend even to the truth that may be unpleasant, uncomfortable, and not beautiful but true; and who feels no impulsion to teach conclusions on all questions of state and society, religion, education, vitamins, and ethics—a man who will sometimes say 'I don't know,' or 'I wonder?' Somewhere, among the species and organs and calories and genes and facts upon facts which constitute biology, there is the making of that man, if we really believe his type is worth making!" *

* Kinsey, Alfred C. *Methods in Biology.* Chicago: J. B. Lippincott Company, 1937. p. 30.

IN-SERVICE TRAINING OF TEACHERS IN SCIENCE *

GLADYS POTTER
Primary Supervisor, Long Beach, California

No one will deny the tremendous role which science plays in modern life. Problems of health, recreation, social life, economics, communication, shelter, production, transportation and consumption of goods, in fact, every realm of human activity is profoundly influenced by science. The contributions of science and possibilities it presents as a means of furthering human welfare have far-reaching significance for every individual in the world today. A knowledge of science is fundamental in making the world intelligible to those living in it.

Present day civilization represents the Utopia of which the ancient peoples dreamed. But social understandings have not kept pace with science and man has not made use of the sound information he has had at hand to promote the general welfare.

The maladjustments so evident in present day civilization filled with such possibilities have come about because man is not sensitive to the incompatibility of many of our "oxcart" social arrangements with the new power potentialities in this scientific age. Understanding is essential if mankind is to "cross over the threshold into the promise of tomorrow." The true benefits of science to mankind cannot be realized from the control of nature or from the use of power unless men see how to apply the scientific information which we now have to the betterment of humanity.

All of these facts are acknowledged by those interested in the general field of education as well as by the specialists in the field of science. And yet the teaching of science in the elementary school has been in no way comparable with its significance. Teachers are aware of the vital interest of most children in both the biological and the physical sciences. Their out of school

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activities are largely devoted to first hand experiences with nature—collecting, exploring or experimenting. And yet in-school experiences with nature study have been too frequently spasmodic or entirely neglected. Casual, incidental consideration has been given to materials which children have brought in, seasonal discussions of flora and fauna, or the spectacular and unusual have been used too occasionally as the subject matter for a nature study "lesson."

There are, of course, several reasons for this treatment of a subject so vital. Teachers have been loathe to attempt more than an incidental program of science teaching because of their own lack of science information and training in this field. They have failed to sense and to capitalize upon the many opportunities in the immediate environment for furthering science interests, appreciations and knowledge. The crowding of the curriculum with many separate subject matter fields has allowed science with its tremendously vital implications to be pushed aside. Science teaching has not had the drive or been given the stimulation which has been allotted to the social studies. Science has been regarded as a subject which needs equipment and apparatus suited only to the secondary level.

How can those of us who are interested in giving science its rightful place in the curriculum change the present practice with teachers now in service? How can children in the elementary school be guided into a deeper understanding of the significance of science? How can we help teachers now in service to open the doors to children so that they may come to a love and appreciation of nature and the contributions of science to mankind?

There seems to me to be three ways in which experiences in the field of science can be part of the elementary school program as it now exists without adding materially to the already overcrowded curriculum. First, by developing all the science implications in the areas of experience now going on; second, carrying on relatively short intensive studies of nature materials found in the environment at some appropriate times during the year; third, paralleling the unit of work program with science interests that are evidenced by children.

In most progressive schools the social living program is organized around large areas of experience. Some of the most commonly accepted areas are the community, the farm, the dairy, trains, boats, carrying the mail, Pueblo Indians, Mexico, pioneer life, history of records, aviation, and the like. Most of these areas are regarded as social studies in the curriculum. But any one that has been mentioned here has many science experiences implicit in it. In the main, the science implications are ignored because the teacher has not been made aware of the possibilities of following the science interests that may arise as a unit of work is developed. She is not herself aware of the implications, the information is difficult to find, and the social aspects of the unit of work have been more emphasized by those who are helping her to lead children through the area of experience than have the scientific aspects. Here is an opportunity for in-service training which is practical and immediate. If the areas of experience which are now a part of the curriculum in our progressive elementary schools were analyzed and those experiences in the field of science which are suitable for young children listed, it would be of immeasurable help to teachers who are eager to incorporate science into the program. Most teachers are too busy with the demands of every day to do this for themselves. Many teachers are not sufficiently familiar with science to do this for themselves. But a committee of teachers under the leadership of a person well prepared in the field of science could draw out of the areas of experience now in

vogue those science learnings which would be possible and suitable, and thus furnish a guide for other teachers using these same areas of experience with their children. There is no thought that the science experiences possible in an area of experience should be set apart or that they would be the same for every group of children. They should be taught as a meaningful and purposeful part of each unit, but to indicate the learnings that are possible, to stress them to provide material that would give the leads to the busy teacher, would help to insure the teaching of science as part of a unit. If the development of these science learnings is left to chance, we will continue to have the neglect of science about which we are all concerned today.

Each city or county needs to do this type of work for itself. The same list would not suffice for all school systems. The areas of experience differ in different school systems. The local environment should dominate the science taught. Interests of children will differ according to the environment in which they live. True, the physical sciences are the same the world over, but interest and experiences with the biological sciences are quite different for children living along the California coast than for those children in the middle west or the far north. Some listings of science learnings such as those drawn from a study of pioneers, Pueblo Indians, Mexico, or the history of aviation may be the same, but the farm, the dairy, community life, etc., will be different in different places.

Examples of possible science learnings in an area of experience might be:

In a study of aviation—the composition of air, air pressure, weather, air currents, gases that are lighter than air, and wind resistance may be studied as a part of making a glider that will fly and the study of lighter than air craft. The information that has been collected through the use of the airplane relative to the migration of birds is a fascinating subject that could readily be developed as a part of the study of aviation. The use of sound detectors in relation to the flight of planes is a timely study.

In a study of Pueblo Indians—the ways in which the climate of the area in which they lived influenced what these Indians did and used is part and parcel of a study of their way of life. The fauna and flora of the southwest; the soil which lent itself to materials for adobe houses and bowls; the yucca roots used as soap; the animals adapted to the arid country and the ways in which these animals served the Indians; the designs used in Indian art suggest the animals and plants with which they were familiar—the turtle, the squash blossom, corn, deer, rabbit, coyote, juniper.

In a study of the dairy—the ways in which domestic animals serve man; the food they need; the care of the young; the storage of food for winter use; the interdependence of plant and animal life; the ways in which milk is made safe for human consumption, the ways in which it is preserved, and the products that are made from milk may all be part of this study.

Another thought in relation to areas of experience is that, in general, those generally indicated for study in the upper intermediate grades, 5, 6, 7, and 8, are more likely to be scientific in nature—the history of records, aviation, history of transportation, and the interests of children at this level will be more largely in the field of science than those of younger children who may be living the lives of people. The emphasis in areas of experience pursued in these upper grades is more likely to be upon the science aspects as they affect society than upon the social aspects that are affected by science. We cannot and should not separate the two but the approach to the study of science may be easier for the teacher in these grades and can more easily be encouraged, and developed more fully because of the very nature of the unit

itself. The active participation of children in enterprises that are meaningful to them, that have purpose for them, will insure real learning. Learning is not passive and no field offers more opportunities for doing, for observing, for exploring, for investigating, and for experimenting than science. The materials are at hand and the interest of children is evident. The organization of learning into large areas of experience is the way to make science a meaningful and functional part of the program. The opportunity is here if we will take full advantage of it.

The second and third way which I suggested for incorporating science into the elementary school curriculum will also need the guidance of supervisors in order to help teachers to see possibilities in their own environment for studying science. The second suggestion was for an intensive study of some phase of science for a few weeks during the school year or at several different periods during the school year. This seems to me much more stimulating than a regular "science lesson"—interests can go deeper, the study will be intensified. It will be less apt to be a textbook kind of science or an incidental study. Textbooks should not determine the science program, for again we must remember that the environment of the child must be considered. Reading about nature is not enough. The studies should be dominated by the local environment. The science interests should be drawn from life situations. The textbooks will then supplement those interests. We need textbooks that will fit the local situations. Our own backyards offer the best laboratories. If the leadership in a school system could organize a series of guided excursions for teachers so that they might explore the sea coast and become familiar with the shells, and the sea life, so that they could become more aware of and recognize the birds, the insects, and the wild life which surrounds them, some of the fears and the inhibitions of the elementary school teachers would be removed. The interests of the teachers themselves must be aroused if a vital program is to go on. The fact that much information is at hand and that the materials of science surround us needs to be brought home to teachers. The ways in which collections may be made, specimens preserved, and out of school interests stimulated would do much to remove the reticence of the teacher whose only experience with science has been in the chemical laboratory of a high school or college.

Days are full of many demands. You may be saying—how can this type of thing be made a part of a city wide or county wide program all too full now for the teacher of little children. Two possibilities seem to be practical. One, institute meetings might take the form of Saturday excursions with a science trained person who would take teachers into the community to observe and explore. The second possibility is that during the summer months teacher training institutions, or a city system, might organize a group of teachers for this type of experience. Three or four weeks would serve to do much to stimulate latent interests and would at the same time provide a means of healthful recreation and adventure for teachers who need the relaxation of out of door life and the satisfaction that comes from interesting, firsthand experiences.

Certain science interests which may be followed intensively in the elementary school might be suggested for concentration for a few weeks or months. This emphasis may be dominated by the seasons. Wild flowers, birds, butterflies, or amphibians may be more profitably studied at one season than another. Other demands in the curriculum may be ignored temporarily until the time for such study is past or until the interest has been satisfied. In my opinion this study need not be designated as a unit of work. I say this because when a unit is developed frequently too many

irrelevant implications are brought into the study because the teacher feels that integration means bringing in all of the other fields of subject matter that might be conceived of as tying into this particular interest. Implications in the study should not be ignored but the values of the science study are sometimes distorted when the need for drawing on other fields is too emphatic. All children in a particular grade need not follow a rigid outline of science but a possible list may be suggested from which the teacher may be free to choose.

The third possibility in a school organized along progressive lines is the one in which certain interests may be carried through the year as a parallel to the main center of interest commonly designated as the unit of work. An example of this kind of emphasis is a study of the weather which may be carried through an entire year. Records of changes in weather, temperature, wind velocity, and so on. Other examples might be birds that are winter visitants, seeds, garden flowers, stars and other heavenly bodies. All of these may be constant and enduring interests that are worthy of time spent at some time during the school day all through the year. As these interests are pursued it is not necessary to go into the far away places. The school grounds themselves offer innumerable opportunities for observation, materials from the environment may be brought into the school room, persons in the community may be called upon to give talks and helps on the things in which interest is centered at the time. Supervisors and teachers may canvas the community to find people who have hobbies or are especially interested in some phase of science. The man who raises bees, the collector of rocks or shells, the man who operates the weather bureau, the home gardener who raises plants suited to the locality, all have contributions to make. If teachers knew of the availability of these persons and called upon them, the persons themselves would become more interested in the schools and would be pleased to contribute to the interest of youngsters in nature. But if the information about the person is not readily at hand, the time goes by when their services would be timely and a golden opportunity has passed.

Some school systems have especially trained persons who help teachers to carry on the science program. This kind of service, however, is rare. In most instances the general supervisor must help the classroom teacher responsible for the total program to carry on with the helps which can be given. The specialist in science in the elementary school would be a great boon to the program but it is the classroom teacher who must give the instruction in science in most school systems. I believe this is as it should be, but the problem in the elementary school is to increase the interest and the knowledge of the classroom teacher who may not have had special training in science and help her to capitalize upon the possibilities that surround her and her children. If we can break down the feeling that nothing can be done in science without the help of an expert, without a textbook to be followed, without a time set aside for the subject as such, we will have done much to give science training to the children now in the elementary school.

The implications for recreational interests that may last a life time, the wholesome release that comes from an appreciation of the workings of nature in a world that seems greatly out of gear, the realization that cause and effect are responsible for many of our problems, a sensitivity to the possibility in the field of science for bettering man's life here and now are important learnings.

These learnings should not longer be neglected. If those of us who are deeply interested in science education can begin by arousing the interests of teachers, by

giving them enjoyable and satisfying experiences in the field of nature, if we can prepare materials and suggestions that will be readily available so that no opportunities for science teaching will be overlooked, we will have come a long way toward giving the children in the elementary school more knowledge about science than they have now.

You in attendance at this meeting give evidence of your special interest in science. As specialists many of you could be of immeasurable help to the general educators who are without your special training, by cooperating in curriculum plans, so that science may have its rightful place in the present day program. Because of the general lack in science teaching in the elementary school, it is essential that additional stress be put on the subject. Social studies groups have been more active than science groups and the results of their efforts are seen everywhere in our public schools. The National Science Committee sponsored by the National Education Association and working under the direction of Dr. Ira Davis has attacked this problem and soon a volume which presents science education from first grade through teachers college will be available to the teachers of the nation. Great numbers of persons have contributed to this volume. It should do much to give the needed stimulation to science education in the elementary school as well as on other levels.

To sum up and conclude what I have attempted to say:

Science should be taught in relation to every study undertaken in the school. Children should explore and understand their environment. No phase of everyday living can be fully understood or interpreted without knowledge of the role science has played. The most significant changes that have come about in the everyday living are due to science.

The responsibility of the school is to insure rich and dynamic experiences for children in an integrative program where science concepts are brought into meaningful relationships. Reading about nature is not enough. Printed symbols are not substitutes for experimentation and observation, and should be used to supplement, not to replace, the firsthand experiences of children.

A prime requisite to successful science teaching is the enthusiasm of the teacher. An abiding interest in the beauty and mystery of nature, and a more intelligent use of the natural environment will result from a well-planned functional program of science in the school, accomplished under the guidance of an enthusiastic teacher. Persons now responsible for curriculum work, for institute sessions, and for summer sessions should develop a practical program that will insure this enthusiasm because of knowledge gained through firsthand experience.

A knowledge of available scientific information and an appreciation of the latent possibilities for the good of mankind in the application of scientific knowledge to social problems, will hasten the day when knowledge and practice will be more closely united.

EMERGING CURRICULA IN ELEMENTARY SCIENCE

M. L. Robertson

New York University

Science curricula in the elementary school have been developing for nearly a century and a half. It is a bit discouraging to observe that at the present time we still have in our elementary schools a heterogeneous mixture of gardening, geography, nature study, and elementary science. In many schools there is no program of science; in many others the time made available for science is very inadequate; in others science experience is so "integrated" with other aspects of school activity that its identity is lost; in still others the amount and nature of science experiences depend entirely upon the enthusiasms and aptitudes of the individual teachers. It seems that school administrators do not want science; that classroom teachers cannot teach science; and that children and their parents do not strongly miss science. If conditions were consistently as bad as this opening paragraph implies, there would be little need to discuss the place of science in elementary school. Such is not the case. Let us review what has been going on in elementary science curricula.

Content has always been influenced by method. The two are difficult to separate. It was primarily from the Pestalozzian emphasis upon object study that the nature-study movement gained its original impetus. He insisted that observation and sense impression were basic to the continuous development of the child. Geography in his thinking was the basic core for natural history and agriculture. Pestalozzi's point of view was a powerful influence in the developing elementary school of this country as we began to extend education beyond the three Rs. With Froebel, the basic assumptions underlying nature-study were different from those of his predecessors and contemporaries. To him the simple knowledge of the facts of nature were of least value. Most important of all were the moral improvement, the religious uplift, the spiritual insight which the child obtained from contact with nature. Despite the unscientific implications involved in such assumptions, Froebel's approach to the content of science in the elementary school exerted considerable influence. Froebel promoted the practice of basing school work upon the nature interests and spontaneous activities of the child as these are called forth by the objects of nature about him. About twenty years after Froebel's death, W. H. Harris introduced natural science into the schools of St. Louis. It was a formalized type of science placing emphasis upon classification and terminology and discarding object lessons as being disconnected and isolated. Such science would likely have persisted had not Louis Agassiz opened his school in Buzzards Bay and inspired a number of able men with the laboratory and field approach to science. Among those who went into teacher training institutions was Henry H. Straight who became professor of Natural Science at Oswego Normal School in 1876. He abandoned object teaching and promoted the study of interrelationships. At the Cook County Normal School, he further extended his work on nature study. Until about 1890 a number of persons promoted this nature-study idea. In 1893, Cornell University took up Nature Study in earnest with Liberty Hyde Bailey[1] and Anna B. Comstock leading the movement. The *Nature Study Leaflets*

[1] Bailey, Liberty Hyde. *The Nature Study Idea.* Garden City, New York: Doubleday, Doran, Inc., 1906.

were established and a good deal of stimulation was given to the movement which spread to many schools in the country.

What is this Nature Study of which we speak?

Bailey describes it: "Nature Study is not science. It is not knowledge. It is not facts. It is spirit. It is concerned with the child's outlook on life." He also defined nature study as direct observational study of common things in the child's environment for the purpose of training the eye and the mind to see and comprehend and thus to gain a sympathetic attitude towards nature for the purpose of increasing the joy of living.

Comstock[2] in her handbook maintains, "Nature Study is . . . a study of nature; it consists of simple truthful observations that may, like beads on a string, finally be threaded upon the understanding and thus held together as a logical and harmonious whole. Therefore, the object of the nature study teacher should be to cultivate in the children powers of *accurate observation* and to build up within them, understanding."

Hodge defined nature study as "learning the things in nature that are best worth knowing, to the end of doing those things which make life worth living."

According to Bigelow,[3] "The most successful nature study of recent years is simple observational study of common things in nature as they interest us in every-day life. The essential elements of such nature study had their beginning in prehistoric times when primeval man discovered that it was to his advantage to know about nature, with which he was in constant struggle. It was a very practical nature study which primitive human beings applied when they kept a sharp lookout for the signs of the seasons and the ways of animals and plants. In fact, as we read the true stories of primitive people, some of whom still exist upon the earth, we are forced to marvel at their great store of knowledge about every phase of nature which might affect their daily life; and it is interesting to note that this useful knowledge consisted of what could be learned by sharp-eyed seeing. Thus nature study, without the modern name, began with man's need for understanding of the living and lifeless aspects of the nature surrounding him."

As late as 1926, the Fourth Yearbook[4] reiterated and crystallized the objectives which like the others were presumed to serve as a basis for content selection:

"Chapter IV. Elementary Science and Nature Study

a. General objectives of education
   To produce a well rounded individual, capable of living a wholesome, happy life, and contributing worthily to the welfare and happiness of others
b. Aims of elementary science education
   1. Ethical Aims
      a. Perception and proper regard for truth —intellectual honesty
      b. Moral uprightness
   2. Spiritual Aims
      a. Sense of the community of nature and of human interdependence
      b. Reverence for, companionship with, and love for nature
      c. Ability to catch glimpses of Cosmic Forces as revealed in natural manifestations, in living creatures, in mankind, and in the record of man's thought and action and aspiration as presented in nature, in literature, music and art dealing with nature and in science
   3. Aesthetic Aims
      a. Creation and appreciation of beauty
      b. Conservation of natural beauty
   4. Intellectual Aims
      a. Appreciation of one's environment through habit of observation
      b. Development of the mental activities necessary to the proper exercise of the many specific functions involved in nature study and elementary science including knowledge of things involved, right attitudes, especially those of sustained interest and habitual curiosity in

[2] Comstock, A. B. *Handbook of Nature Study.* Ithaca, N. Y.: Comstock Publishing Co., 1929.

[3] Bigelow, M. A. "The Evolution of Nature Study." Read at the annual meeting of the American Nature Society, Des Moines, Iowa, December, 1929.

[4] Fourth Yearbook, Department of Superintendence, National Education Association, 1926.

nature study and elementary science, and right valuations and appreciations.

5. Social Aims
   Ability and desire to contribute worthily to home life and the life of the community
6. Civic Aim
   Stimulation of thought, feeling, action and reaction as an efficient, intelligent, sympathetic, and loyal member of a large social group
7. Economic Aim
   Conservation of useful forms and control of injurious
8. Vital Aim
   Maintenance of physical efficiency
9. Avocational Aim
   Wholesome use of leisure and enjoyment of outdoor recreation
10. Vocational Aims
    a. Sufficient knowledge of the raising of flowers and vegetables, chickens, pigeons, rabbits, etc., of tree planting and the like to facilitate a choice of vocation in later life.
    b. Ability to produce the necessities of life
11. Practical Aim
    Ability to make use of the forces of nature and science for personal betterment"

What kind of content did these early workers deem suitable?

Comstock organized her handbook into animal, plant, and earth and sky with birds, fish, batrachians, reptiles, mammals, insects, trees, flowers, cultivated plants, with excellent stories and directions for observations. Of course, in a handbook there was no attempt at continuity. In courses of study similar plans were followed for many years, e.g., in 1927, a committee from Denver Public Schools aided by a number of nationally known curriculum experts, in Monograph 21, *Science in the Elementary School,* utilized the same three categories in a 135 page document. They did substitute "Other Animals Forms" for "batrachians" under Animal Life. Also, a chart was set up that prevented the children from discussing the elm tree two consecutive years. It was however an excellent course of study of its kind with many refinements.

During this period of development alert teachers became curious concerning materials which children observed and concerning those in which they appeared most interested. There began a series of interest studies which have continued, with refinements and modifications of purpose, of course, to the present time. Batholomai, Lange, Trafton, Libbey, Mau, Downing, and Finley, were the early investigators of science interests. Palmer started his question gathering in 1921 but it was not reported until later. You are likely familiar with the details of these studies.[5] The conclusions may be summarized briefly as:

1. The order of children's interests in science materials seems to be the following: animals, then plants and thence to physical materials.

2. The order of interest in animals from the lower to the higher grades seems to be: identification, life habits, life history, adaptations, and structure.

3. Elementary pupils have a limited acquaintance with plants and animals.

In the same period Patterson, Thompson, and Hillman analyzed a total of 168 courses of study to determine the status of nature study. They found

1. That the content was to a large extent biological.

2. While there were rather uniform purposes in the courses studied in 1913 (Patterson), there was little agreement in those analyzed in 1924 (Hillman).

3. Emphasis upon plant and animal life in primary and upon physical and chemical aspects of the environment in intermediate.

The wide variety of courses noted in 1924 indicated that although the nature study enthusiasts were struggling valiantly, nature study was not fulfilling the hopes of the early leaders. Things were happening too fast. The old faculty psychology with its reliance on mental discipline was discredited. The saltatory theory of learning that implied that young children were different from other children in their thought processes was gone.

[5] Robertson, M. L. "A Review and Evaluation of the Curricular Studies Pertaining to Elementary Science." *Science Education* 18: 86–93.

Craig at about this time wrote:

"Traditional nature study is bound, however, by several weaknesses. First, as defined by many of its authorities, nature study should stop with the mere observation of nature. Scientific generalizations, principles, and laws have no place in the elementary school. It is assumed that the level of the upper grades marks a period of great change in the mental ability of children. Presumably children enter this level, which corresponds to the period of the onset of adolescence, with the ability to generalize quite dormant, and they emerge with the ability active. It must be remembered, however, that the point of view of many nature leaders is a resultant in part of a revolt against the earlier formal class procedure which would have tended to make nature study a mere memorization of principles. Second, sequence in organization is almost foreign to the traditional nature study. Each teacher is naturally ignorant of what should go before or come after her instruction. Third, the goals of traditional nature study are based on the older conception of transfer of training. Almost every desirable trait and habit has been promised boys and girls by enthusiasts if they will but study nature." [6]

That was the beginning of the end for Nature Study. With the growth of the general science movement subsequent to 1910 with its more critical evaluation of content, pressure appeared from teachers of general science and administrators for a resurgence of science in the elementary school; one teaching a related program of science experiences and contributing to the more even growth of boys and girls. A new orientation of the content was needed.

Many persons played at selecting and "doctoring up" the content in such a manner that it would be suitable for the expanding elementary school. But Gerald Craig made the first real break with the past in 1927. While developing a course of study for the Horace Mann School, he established a series of objectives based upon the criteria that science should conform to those scientific conceptions which were fundamental to modern life; that it should conform to those goals that are important in establishing health, economy, and safety in private and public life; that it should conform to those facts and principles of science that are essential to the interpretation of the natural phenomena of the environment; that it should conform to the purposes of acquaintance with and the identification of the environment; and that it should conform to those goals suggestive of means of securing standards of action.

Craig presented the 82 objectives secured by his preliminary study to a group of educated laymen for ranking on the basis of their opinions of the need for these objectives in their lives. Also he secured some seven thousand questions from boys and girls of elementary school age and evaluated these objectives on the basis of their needs in answering children's questions. Next he evaluated them on the basis of the meanings developed in authoritative source books of science. He used these evaluations as a basis in building the Horace Mann Course of Study. This study is the most extensive and reliable that had been published dealing with the content of elementary science. The technique used revealed over one hundred appropriate objectives of elementary science. These objectives were statements of scientific concepts, e.g., "The sun is the source of light and energy." "Some forms of life are minute."

In 1932, a Committee of the National Society for the Study of Education in its yearbook entitled "A Program for Teaching Science," endorsed Craig's point of view and rather officially adopted the term, "Science for the Elementary School." Later, Craig's series of books and his professional book, *Science for the Elementary School Teacher,* illustrated the approach. The implication in the writing that children could make generalizations set these volumes apart from those written by the earlier authors. Robertson [7] found these

[6] Craig, Gerald. "Science in the Horace Mann Elementary School." *Teachers College Record* 28:246–254; November, 1926.

[7] Robertson, M. L. "An Investigation to Determine the Relative Effectiveness of Two Methods of Teaching Elementary Science in the Fifth Grade." SCIENCE EDUCATION 16:182–187; February, 1932.

curriculum materials entirely suitable for the fifth grade. Later, he obtained a list of principles [8] of science by refining lists occurring in previous investigations at the high school level. This composite list was rated by a jury of fifteen experts with respect to their appropriateness as ultimate goals. One hundred and thirteen principles were obtained. Some 2000 contributory topics were secured from six previous investigations and were combined statistically into a single list. The list of principles was evaluated in terms of children's questions. The time was ripe for such studies emphasizing the broader aspects of science in the elementary school. The agricultural and recreational science of the early 1900's no longer was adequate for the interpretation of the changing character of life. Recent years have witnessed unusual growth in the contributions of science to social living.

Human suffering has been alleviated and longevity increased by the general use of anaesthetics, by improved surgical techniques, by gynecological advances, by constant advances in immunizing against disease, by increased community sanitation, and by the dissemination of information concerning the influence of diet and the ductless glands upon health.

The hours and nature of human labor in the factory, on the farm, and in the home have been changed by the constant production and refinement of devices and machines. Shoes that took many hours to make by hand labor can be stamped out, sewed, and assembled in a few minutes. Automobiles that would take many days to machine and assemble by hand labor come completed from the assembly lines of the factories in a steady stream. Enormous tractors plow more than a dozen furrows at a time on the farm. Machines called "combines" harvest, thresh, and bag grain in one operation. Cows are milked by machines, and water is pumped automatically by self-starting engines.

Homes are equipped with washing machines, refrigerators, flowing water, ironers, dish washers and cleaners, telephones, dumb waiters, automatic furnace stokers, and regulators.

The entire character of home life has been changed by scientific inventions. Family groups no longer spend their evenings playing games, eating apples and popcorn, or singing to the accompaniments of the organ. There is now the radio, the nearby movie, the fast motor car. Food for the family no longer depends upon the productivity of the soil of the immediate region. Iceless refrigerators, refrigerator trains, dry ice, tin cans, and effective tariff regulation have made a wide variety of foods available to all parts of the country at all times of the year. All of these advances were a part of life and clamored for understanding on the part of boys and girls. Theories of learning had passed through many stages from the older transfer concept involved in mental discipline, through the idea of sudden changes in pupil ability, the putting of ideas upon the "waxen tablet" of the immature minds, to the more modern connectionist, behaviorists, Gestaltists, genetic, organismic psychologies. Too, the approach to the problems of the school became less idealistic and more pragmatic.

Since Craig turned the tide, elementary science has been a dynamic field. The curricula wouldn't "jell." In those places where the teachers were alert they were being modified every few years. Some used new psychologies, some the old ones. Some improved their nature study programs; others switched to the generalization or other approach.

Haupt [9] in 1935 stated the issues rather

[8] Robertson, M. L. "A Basis for the Selection of Content in Elementary Science." SCIENCE EDUCATION 19:1–4; 65–70; February and April, 1935.

[9] Haupt, G. W. "An Experimental Application of a Philosophy of Science Teaching in an Elementary School." New York: Bureau of Publications, Teachers College, Columbia University, 1935.

clearly as a result of his investigation:

1. Shall the aim of elementary science be of the "moral, vocational, aesthetic, civic, ethical, and spiritual" with goals of attainment such as "moral uprightness" *or* shall it be of the generalization or objective type of attainment such as "Space is vast?"
2. Shall activities of observation; collecting and identification be ends or means to interpretation?
3. Shall science content be predominantly biological or shall it draw from all fields?
4. Shall or shall not personification and omission be used for motivation?
5. Shall grade placement be in terms of branches, i.e. biological, then physical or shall difficulty and complexity of content be the basis?

He then proceeded to investigate the kinds of generalizations pupils possess. His study revealed two philosophies:

1. Experiences should be provided which permit interpretation and which contribute to large generalizations since children are capable of this kind of mental activity.
2. Young people are *not* capable of such activity and therefore experiences should consist mainly of observations.

When he studied pupils' concepts he found:

1. Difference in concepts and association of concepts.
2. Concepts on low levels depend upon few experiences easily acquired or presented.
3. Concepts upon higher grade levels depend upon a series of experiences which must be related and held—not easily acquired or presented.
4. More concepts are associated in statements at the higher grade levels.

When he studied learning of children in science he found that:

1. Learning depends upon complexity of the elements.
2. Difference in learning involves the number of associations from experiences, therefore, there is no real difference in kind of mental activity, but there is a difference in complexity.
3. An understanding is approached through the interpretation of varied experiences in such terms of the principle as are possible at the grade level.

Joe Young West [10] in his doctoral dissertation offers a technique for recording pupils' responses objectively and (incidentally, determining the growth of complexity in associations suggested by Haupt) also community of way of thinking on different levels with respect to critical-mindedness, openmindedness, causal relationships, generalizing, scientific problem attack, and recognition of interpretations of phenomena.

Croxton [11] helped out by finding that in general, ability to generalize and apply generalizations increase with the grade. Also, he determined that:

1. Higher primary and intermediate pupils are capable of generalizing.
2. Little in experiments to indicate that junior-high-school pupils possess markedly superior ability to generalize than intermediate pupils possess. What differences that occur apparently chargeable to added experience.

It would seem that elementary science was well on its way; organized in accordance with the Yearbook recommendations and with the research into a continuous program of experiences producing generalizations as outcomes and increasing in complexity each year within the same area.

Programs prepared to articulate readily with the junior high school science, e.g., the 1939 revision of the New York State Syllabus for Science in the Elementary School utilizes six content areas stated as generalizations:

1. There are many kinds of living things upon the earth.
2. Earth conditions change.
3. Matter and energy are subject to many changes.
4. The Earth is a small part of the Universe.
5. Plants and animals survive many changes.
6. Living things are interdependent.

A continued analysis by grades of problem three follows:

Grade 1. Air surrounds us.
" 2. a. Water passes through many changes.
b. Magnets push and pull things.
" 3. a. Heat comes to us from the sun.
b. Work can be made easier.

[10] West, Joe Young. *A Technique for the Appraising Certain Observable Behavior in Science in Elementary Schools.* New York: Teachers College, Contributions to Education No. 728, 1937.

[11] Croxton, W. C. "Pupils Ability to Generalize." *School Science and Mathematics* 36:627–634; June, 1936.

Grade 4. a. We get electricity in several ways.
b. Light enables us to see things.
" 5. a. Substances are always being changed.
b. A layer of air surrounds the earth.
" 6. a. We can make electricity work for us.
b. Sound travels through matter.

Such programs must start some place and go some place. They take a leaf from the book of the mathematics teacher. If certain abilities in higher mathematics are based upon fundamental concepts, these are introduced in the program at a place consistent with the maturity of the pupil. Each year pyramids understanding, counting, addition, subtraction, division, and so on. Similarly, appropriateness is basic to the above type of organization.

There are many modifications in approach to the continuous program. In some cases, such as the curriculum in the laboratory schools of the University of Chicago, the planned experiences and units appear very much like the older nature-study-approach of unrelated areas, but upon examination it is found that the outcomes are *core ideas* and that they increase in complexity with the increase in the grade level. Of course, there are cities of considerable size in which the new syllabus adheres to the more ancient outline of fall, winter, spring and under these, trees, insects, birds, animals, flowers, weather and sky—in spite of their state outlines. For that matter, nearly any stage of curricular development may be found exemplified in "modern" outlines.

Another extension of the continuous program idea had its tap roots deep in the general science program. It involved the use of major areas of environment to which the pupils adjust and with which they have personal or vicarious relationships. The adjustment point of view, given voice by H. C. Morrison in 1925 and immortalized in the Unit-Method, can apparently be utilized in elementary science. The bases for selecting the content are not primarily the principles and generalizations of science or the spontaneous interests of the children but are obtained from an analysis of life activities plus a consideration of the needs of children.

According to this view life activities are dynamic and guides for the selection of content may be expressed by *verbs of doing,* such as, care for, use, obtain, improve, predict, select, control and grow. A somewhat different selection of specific content items than those selected to contribute to generalizations result from this approach but similar principles of increasing complexity of concept in the continuity of grade experience applies. The program in Manhasset, N. Y., is a rather good example of this approach in practice. Elements of this approach also appear in the series of books with which W. L. Beauchamp is associated.

Another type of pupil experience, I am not sure that I can call it a curriculum, arises in connection with the various activity plans. The curriculum is a series of "projects" many of which arise spontaneously and into which are integrated all the learnings that were formerly developed by more traditional means. It implies that the following ideas are acceptable:

1. Growth (desirable), wholesome personality and social adaptation are sought as outcomes.
2. Activities center around and grow out of child's own purposes and interests. It is "child-centered."
3. Creative expression, pupil initiative, pupil activity, freedom, and self-evaluation are stressed.
4. An attempt is made to preserve child's personal identity.

Briefly:

1. The activity curriculum emphasizes child life.
2. The activity curriculum emphasizes the principle called "integration."
3. The activity curriculum emphasizes social contacts.
4. The activity curriculum emphasizes the method aspect of learning.
5. The activity curriculum serves the life and needs of pupils here and now.
6. The activity curriculum takes its subject matter directly from real life.

For example, in curriculum making the guppies in the aquarium of the classroom

have babies and the children become interested in reproduction and develop an activity involving the whole problem.

They read a story about Hawaii and among other things develop an activity on comparative climates. Anecdotal records kept by the teachers of a particular school provide for continuity of experience and for increase in complexity of concept. Such anecdotal records can become a curriculum only when the teachers set the stage each year in such a manner that similar problems will arise. With all its assumed advantages the plan has many of the weaknesses of the incidental method of teaching. However, 50,000 children in New York City are experimenting with such a program successfully according to Associate Superintendent John J. Loftus. Public schools in Roslyn, New York, Fox Meadow, Scarsdale, and Bronxville, N. Y., subscribe in principle certainly to such a program.

Another factor unconsciously tending to redirect science in the elementary school is the recent report of the Science Committee of the Thayer Commission on Secondary Education—*Science in General Education.* This group has tried to clarify the function of general education in a democracy and the relation of scientific teaching to it. Their restatement of the purpose of education says "to meet the needs of individuals in the *basic aspects* of living in such a way as to promote the fullest possible realization of personal potentialities and the most effective participation in a democratic society." The committee further defined the *basic ideals of democracy* to involve

1. Distinctive personalities.
2. Use of cooperative means.
3. Intelligence growing out of free association and communication.
4. Person should be socially sensitive, tolerant, cooperative; use reflective thinking on problems and be self-directive.

The curriculum materials are centered in basic aspects of living such as personal living, home and family life.

Although intended for the secondary school the possibilities for its extension into the elementary school is clearly illustrated by Rose Lammel in the February, 1940, issue of *Progressive Education.* She shows rather ably by describing specific situations how the activity program in the elementary school of Ohio State University contributes to the aims set forth by the commission and remains within the categories of the basic aspects of living. If this report becomes a yardstick for the "progressive" elementary schools of the country there will be a new reorientation and selection of content contributory to the outcomes desired.

Now a new force looms upon the horizon—a series of committees national in scope—working under the science section of the N.E.A. and integrated by Ira Davis of the University of Wisconsin—are rewriting the basic assumptions of science education—they are guided by the criteria of the Educational Policies Commission and should obtain in their reports a clarification and integration of the thinking of the whole country. Just how much change there will be in curricular elements when these committees make their reports this summer is hard to predict, but it looks very hopeful.

In addition to the activities of the science teachers there is a number of forces aiming to modify the curricula—reports like that of the Board of Regents Inquiry in New York have a story to tell. The *growing reaction* against political progressivism in the United States may spread to progressivism in the schools and by modifying the purposes of education may change the direction of the selected content. The present national emergency with its stated needs for victory gardens, safety, first aid, and recreation may temporarily at least redirect the curricula.

In summary there are three kinds of curricula still extant:

1. A science curriculum made up of relatively discontinuous nature study elements.

2. A science curriculum consisting of a related program of continuous experiences producing larger and larger generalizations from life experiences or solving more and more complex problems of living.
3. An integrated curriculum in which the science is rather incidental to the total development of the child in his social activities.

In the opinion of many persons any of these curricula intelligently taught come close together in ideals, procedures and evaluations. They must produce children who in their every day living

1. Exhibit certain of the attitudes of the scientist (openmindedness, tolerance of other's opinion in absence of evidence, desire to observe, recognition of causal relationships).
2. Think logically—know the limits of their problems, recognize pertinent data, check their hypotheses, conclusions.
3. Become, through science, more efficient, intelligent, and healthy young citizens.

SCIENCE EDUCATION FOR PROSPECTIVE ELEMENTARY TEACHERS

HELEN DOLMAN BLOUGH
Colorado State College of Education, Greeley, Colorado

In a discussion of the preparation of elementary teachers for meeting the science problems of children, we need to consider several factors.

First, the varying curricula and working plans of the schools in which these prospective teachers will go. Some of them will go into small communities or towns, some into large city systems in industrial, mining or other areas. Some will undoubtedly teach their first few years in rural schools. Some will find cooperative, progressive school boards and parents, while others will have to follow traditional, conservative programs until they win the confidence of the community. If these last go out with enthusiasm and lack of preparation for meeting such situations they may find themselves without jobs. Tact and patience might make it possible for them to gradually introduce a science program.

In the second place, we must consider the social and educational backgrounds of the students we are preparing. In the average teachers' college we have a heterogeneous student group. In the two colleges in which the writer has taught, many of the students are from farming communities, some are from cities. In the same classes are students from rural elementary schools, town and city schools. A few are from small mountain schools taught by poorly prepared teachers. Sometimes these schools have the children of just one or two families. One teacher had her own two sons and five other boys. Another had two students. To be sure these may be exceptional cases, but they should be recognized in any study of the needs of the elementary teacher.

The third factor to be considered is the relative importance of science to the development of the individual, both as a child and as an adult. As scientists we may be inclined to over-emphasize the value of a body of knowledge, without which numbers of human beings have lived happy and useful lives. What assurance do we have of the validity of our objectives? Are our motives directed toward helping these people to develop individual capacities or are we eager to fill their minds with a mass of scientific facts?

Doubtless most college teachers at the present are genuinely interested in individual student growth. Granted that we recognize all of these factors of teacher-community relationships, varying individual backgrounds and the place of science in the general educational program, many of

us are concerned with how best to accomplish our aims.

Science for children is such a new field as compared with the skill subjects and the social studies areas, that we have no traditions. There is little agreement between courses of study and textbooks. The few specialists in the subject differ in their philosophies. However, they do agree rather generally on the major objectives for teaching science.

This then offers us a beginning with which to start our teacher education program. As these students come to us in our methods classes we can give them diagnostic tests to discover their scientific attitudes or lack of such attitudes, their abilities to recognize and attack problems, and their basic science concepts.

Most of these people will have had some general science or biology in high school. Many colleges give some sort of science survey courses to freshmen. Thus the methods teacher can presuppose some science background in the sophomores, juniors or seniors who come into the methods classes. However there will always be some students from small high schools, or transfer students from other colleges, who do not remember having had any science.

The diagnostic tests will reveal some of the individual deficiencies. If the methods course is given for just a term or semester, about all one can hope to do with these people in building a science background is to correct misconceptions and teach the biological and physical principles needed to teach science to children. Every study that has been made of adult misconceptions in science has shown an amazing number of them. The writer uses a misconception test at the beginning of each term. This serves the dual purpose of showing students their own incorrect ideas, and of arousing interest.

We frequently find that students who have taken some science heartily dislike it. Those who haven't had any science often fear it. So the instructor's first task is to arouse interest and destroy misapprehension. This can't be done by giving assignments in college science texts. The average college student who isn't a science major doesn't have the vocabulary with which to read college science texts.

Fortunately texts are now available in the Teaching of Elementary Science that help to remedy the reference problem. We still need to remember that these students, though adults, are as children in this strange field and can't assimilate science concepts as rapidly as they are often expected to. As one graduate student in an Elementary Science class said, "College teachers need to realize that many students have grown to adulthood without ever having learned the most elementary science concepts."

Most teachers know many ways to arouse interest and break down the fears that act as barriers to active participation in the science program. These vary with different groups, seasons, environments and college set-ups. Some of the same devices we use with children work equally well with adults. Using live material to stimulate questioning, field trips to point out the features of the environment which might stimulate child questioning, reports of current happenings in science, and actual participation by the students in the science program are examples of motivating activities. The important thing is to recognize that an adult class needs to be stimulated as much as children do.

The sooner the class can come in contact with children, the more vital it will be to them. A methods class taught away from the children is like a class in surgery without any laboratory experience. For several years the writer tried to teach the theory of teaching science to children only to discover when she tried out the theories on children, that they didn't work.

In some colleges the only way this student-child relationship could be accom-

plished might be through demonstration teaching of borrowed children. If carefully planned and discussed afterward this is an excellent way to bring out teaching techniques. If possible, students should have the opportunity to work with the children. This may be done by dividing the group of children and letting students help direct or share their activities.

All of these experiences help students to feel that they are a part of a program, not just a class to be lectured to.

Having aroused interest, the next thing the instructor does is to set up objectives or reasons for teaching science. He will probably discover that the class may be able to recite these and still not be able to recognize them as behavior responses in children. For example a student may be able to list scientific attitudes without having these attitudes himself or recognizing them in others.

Before a teacher can help children to develop desirable attitudes and habits, he not only has to have them himself, but be able to see a lack of them in children.

For example, a fifth grade class was discussing the way a scientist thinks. They made this list:

1. A scientist is patient and doesn't give up.
2. A scientist proves his answers.
3. A scientist thinks through what he is going to say.
4. A scientist needs to prove something many times.
5. A scientist thinks through the opinions of others.
6. A scientist is willing to change his mind when he learns that he is wrong.
7. A scientist knows that there is a reason for everything that happens.

Some of the college students who were observing the class didn't realize that these were scientific attitudes, because they weren't stated as 1. Persistent search for truth, and so on.

After students have observed the regular science classes for a time, trying to find examples of the scientific attitudes or lack of them, they become quite skillful in doing so. Then they are ready to discuss the techniques for teaching these attitudes.

Similarly, in helping prospective teachers develop techniques for teaching problem solving we must first teach them how to recognize problem situations, formulate good problems and follow the steps in the problem solving method. They may have learned this method in previous science classes and be able to demonstrate it by setting up a problem in a familiar area and solving it. The methods teacher needs to learn whether this is really a part of the student's thinking or something repeated by rote, as one can recite a rule in Algebra without understanding it.

Knowing this, the student may observe children and write a summary of a problem solving lesson to demonstrate his ability to analyze the steps in such a lesson. If it is possible for the student to plan and teach such a lesson with discussion and criticism with the teacher afterwards, all the better. The writer for several years was able to teach a methods class by the laboratory technique. The students invariably expressed their satisfaction in this active participation.

Working in groups, students may also set up problems to be used when they begin their teaching experiences. These may be grouped under subject matter areas, such as Earth Study, Living Things and Beyond the Earth. They may be grouped under age levels, such as Primary, Intermediate and Junior High. They may be under community groups, such as Rural, Industrial, and Small Towns. The class should discuss and decide the way they wish to work on these group problems.

Having formulated their problems, each group may then analyze these for the children's interests in such problems. They may then devise, collect or find the teaching materials they would need to help the children solve their problems.

A class that has been working on this

plan has done some original thinking about current problems, which they are apt to have to face next year. These problems have meaning for the students because they can see a practical application. Some of these problems are concerned with rationing, keeping physically fit and the use of substitutes.

Although these source units of teaching materials as written may not fit into the future teaching programs of these students, the construction of them is a worthwhile experience. Evaluating it the students feel that through such an activity they have received these values:

1. Greater appreciation of the ramifactions of science into the everyday experiences of children.
2. Ability to formulate and state worthwhile problems.
3. Ability to select varied activities which will help children solve their own problems.
4. Ingenuity in adapting experiments and demonstrations to materials available in any rural school.
5. Some experience in handling apparatus and demonstrating before a class.
6. Acquaintance with reference books for children and teachers.
7. Greater ability to work cooperatively on a group unit.
8. Six or eight source units with problems, activitives, references to teachers' books, children's books, visual aids, free or low priced materials, and teachers' information.

Former students who are now teaching say these units were very helpful to them in starting their science work.

Participation by the students in the care of the children's Science classroom gives them a feeling of sharing in the teaching. Working again in groups they construct bulletin boards, balance aquaria, make terraria, arrange exhibit tables and set up simple demonstrations. Where possible, children help the adult students.

For example, two college students worked with a fifth grade in making a bulletin board on Underwater Craft, summarizing the problem, "How do submarines, diving bells and other underwater devices work?"

Besides appreciations, scientific attitudes, skills and habits of problem solving and knowledge of where to get materials, prospective teachers need to know how to help children develop science concepts. Experienced teachers naturally do this psychologically. They know how confused children become when the teacher goes too fast for them or when she tries to teach too many new concepts in a period. Students in science methods may be helped in learning to be skillful teachers by teaching them how to analyze major concepts for the simple concepts necessary to their understanding. By arranging these concepts in the order of their complexity students will begin to see the order of concept development.

The suggestions given in this article are not considered adequate nor perfect for the training of elementary teachers. Where time is a factor we have to choose between doing a few things well and skimming over a larger amount of material. After trying various methods for a number of years the writer is convinced that in one term it is better to concentrate on these things outlined than to strive for a comprehensive background of subject matter.

Given interest, good scientific attitudes, ability to solve problems and a knowledge of where to go for information, teachers will fill in their own knowledge gaps as they need it.

We still need these things in our teacher training program:

1. More adequate diagnostic tests for evaluating appreciations, attitudes and habits.
2. More attractive reading material for adults. Continually students are found reading the children's science texts. Why should books for adults be so difficult to read as to discourage students? They should be accurate. They need not be of the popular style but clearly written.
3. More studies of the needs of the average

elementary teacher so that we can anticipate these needs and plan our programs.

4. More opportunities for the students to share in the planning and evaluating of their own course so it may meet their needs.
5. More attention in our programs to vital human problems so that we can help students learn a scientific approach to such biological needs as sex-education and physical fitness.
6. More effective program of pre-college science so that students may come to the science methods classes with as many understandings in the science areas as they have in the social studies or literature.
7. Finally, a follow-up program of in-service training to help teachers on the job.

RECENT BOOKS FOR ELEMENTARY SCHOOL SCIENCE CLASSES

FRIEDA M. HELLER
Ohio State University, Columbus, Ohio

During the past twelve months or more many books for children have appeared. These cover a variety of subjects for they represent recognition of the widening range of a child's interests. As a consequence from the presses have come books of poetry, stories of adventure, accounts of the childhood days of interesting personalities, imaginative stories and folklore, books on "how things work," and titles that explain the world in which a child lives. Some of these books are pocket-sized; others are large picture books. Some are full of illustrations carrying clarity as well as beauty; others carry few illustrations. Some are simple in text so that the beginner may read for himself; others are more difficult and designed for the older user.

The changing school curriculum is reflected in the wider selection of books for children and schools are interested in a rich, varied collection of reading materials. The newer concepts and trends in science education demand books meeting unit needs. To meet these demands the books must be written by persons of authority; the material must carry the qualities of accuracy and recency; and the subject matter must be presented to the young reader in a clear and simple style. Of the books recently published for children some will prove valuable as material to enrich the teaching of science at the various grade levels. The titles listed below are recommended for that purpose.

BRIDGES, WILLIAM. *Big Zoo.* (Photographed by Desider Holisher.) Viking, 1941. $2.00.

Interesting text and exciting photographs pictured for grades four to eight things that go on day after day at the Bronx Zoo. The author, curator of publications for the New York Zoological Park, reveals the way the animals are brought to the zoo, how they are cared for, how they are exhibited, and something about those who care for them.

BROWN, MARGARET W. *Baby Animals.* Random House, 1941. 50¢.

Picture book for pre-school children and those of the earlier grades. Full-page pictures and simple text present familiar animals, birds, and fishes telling how they spend their days.

BROWN, MARGARET W. *Bumblebugs and Elephants.* (Pictures by Clement Hurd.) Wm. R. Scott, 1941. $1.00.

Familiar animals, large and small, of water, woods, and barnyard are introduced to the two- and three-year-old children by means of rhythmic verse. Blue, green and red are the colors used to provide the gay illustrations which accompany the text.

BUCK, MARGARET W. *Animals Through the Year.* Rand, McNally, 1941. $2.00.

Actual facts about twenty North American animals are arranged according to seasons. The

well-written, clear information will be useful with children of eight to ten years in age. The many pictures and the large type will invite use of the book.

DUNHAM, MIRIAM P. *What's in the Sky?* (Illustrated by Dorothy Waugh.) Oxford University Press, 1941. $1.00.

A fascinating little book explaining briefly the elementary facts about astronomy. Children from eight to twelve years old will find useful information concerning the solar system, the stars, the comets, the meteors, light years, and other astronomical matters. Diagrams and illustrations.

EDEY, MAITLAND A. *American Water Birds, Also Hawks, Owls and Game Birds.* Random House, 1941. $1.00.

A title useful with all ages covering the familiar water birds of eastern and central United States and Canada. The text is brief but clear and accurate. The colored illustrations are from the old plates of Louis Agassiz Fuertes. A companion to the author's earlier *American Songbirds.*

FLYNN, ROSE. *Peggy Plants a Tree.* (Illustrated by Gertrude Howe.) Scribner's, 1941. $1.50.

By means of an interesting narrative the author tells of how Peggy made her first acquaintance with trees when she moved to the country. Through the facts given in the story and use of the pictorial guide to tree leaves found in the back of the book, children of the middle grades can discover much about the trees of their own locality.

GALL, MRS. ALICE C., AND CREW, FLEMING. *Bushy Tail.* (Illustrated by Else Bostlemann.) Oxford University Press, 1941. $2.00.

Children of grades three to five have liked the previous books, *Flat Tail* and *Ringtail*, by these writers and they are now welcoming *Bushy Tail* —the adventures of a young chipmunk. This is not only the life story of a curious chipmunk but also that of other creatures of the forest and their struggle to survive during the changing seasons.

GRONDAL, FLORENCE A. *Stars; Their Facts and Legends.* (Illustrated by Ralston Crawford.) Garden City Publishing Company, 1940. $1.00.

Simple stories and legends concerning the stars and constellations for children under twelve. The book will help to stimulate interest in mythology and will make an excellent first book for the youngster interested in the sky.

HOOGSTRAAD, HARRY. *Insects and Their Stories.* (With camera studies by Melvin Martinson and drawings by Carl O'Mohr.) Crowell, 1941. $2.00.

Many boys and girls are interested in identifying the insects of garden, woods, and house and by use of this book they will be able to do so. Brief interesting text describes the appearance, structure and development of each insect and explains how and where it breeds and lives. The full index and guide to the insects named aid in making this a very useful book for grades five to eight.

HUNTINGTON, HARRIET E. *Let's Go to the Seashore.* (Illustrated with photographs by the author.) Doubleday, 1941. $2.00.

An excellent first book for children of grades two to four. Descriptions of the small creatures which live in the sea and on the shore are given in simple words and short sentences. The text is scientifically accurate but simple enough for young readers. Full-page photographs and illustrations in soft sea-green tones add to the book. An earlier companion volume was the author's *Let's Go Outdoors.*

JACKSON, MRS. ANN. *The Wonders of Oil.* Dodd, 1940. $2.00.

A simple account of the story of the oil industry for grades five to eight. George's visit to the old fields provides the form of the story which in a way is unfortunate. Nevertheless, the book is very readable and contains useful information concerning how oil is found, methods of drilling, storage, refining and transportation.

KANE, HENRY B. *The Tale of the Bullfrog.* Knopf, 1941. $1.25.

A factual story of the development of a tadpole into a full grown bullfrog. Photographs or pen and ink drawings are found on each page of the text and some of them give pictures of natural life under and around water. For ages eight to twelve.

LEMAY, GERALDINE. *The Story of a Dam.* Longmans, 1941. $1.50.

A non-technical account of the building of the Norris Dam and a brief glimpse of the work of the Tennessee Valley Authority in flood control and reforestation. Photographs show step by step the construction of the dam. For children from ten to thirteen years old.

MCKENNY, MARGARET, AND JOHNSTON, EDITH F. *A Book of Garden Flowers.* Macmillan, 1941. $2.00.

Favorite garden flowers are arranged according to season and a description facing each picture tells of the plant's origin as a wild flower. Lithographs are used for illustrations and in addition to these there are little drawings of seeds to complete the cycle of bud and blossom. This is a companion volume to the authors' earlier, *Book of Wild Flowers.*

PARKER, BERTHA, AND PARK, THOMAS. *Animal Travels.* Harper, 1941. $1.00.

An inquisitive child may be led to searching for more information through the use of this simple discussion of three kinds of migration; normal, periodic and occasional. For intermediate grades.

———. *Animals of Yesterday.* Harper, 1941. $1.00.

A discussion for the intermediate grades of why dinosaurs disappeared and what fossils are and how they are preserved in museums. Covers prehistoric birds, early sea animals, and ancient land animals.

PARKER, BERTHA M. *Fishes;* checked for scientific accuracy by Walter H. Chute. Illustrated by Elizabeth Newhall. Harper, 1941. $1.00.

———. *Seeds and Seed Travels.* Illustrated by Olive Earle. Harper, 1941. $1.00.

Both of the above titles contain basic information on the subjects named. Attractively illustrated in color. (Also in pamphlet form in the *Basic Science Education Series* from Row, Peterson and Co.)

PEET, CREIGHTON. *How Things Work.* Holt, 1941. $2.00.

Simple physics and mechanics are presented to young readers in an informal manner. This is done by recounting how two boys learned about leverage, centrifugal force, and so on from the objects in use around them in everyday life such as bottle openers and lawn mowers. For grades four to seven.

PERRY, JOSEPHINE. *The Rubber Industry.* Longmans, 1941. $1.50.

Follows progress of rubber from the discovery of the raw material to the manufacture of rubber products and rubber substitutes. Good, clear photographs illustrate the test. For grades five to eight. (This is one of the factual books for young readers in the series, "America at Work." Others are *Fish Production, Milk Production, Forestry and Lumbering, Story of a Dam.*)

RECK, FRANKLIN M., AND RECK, CLAIRE. *Power from Start to Finish.* Crowell, 1941. $2.00.

A clearly written and simple account of the story of coal, oil, water power, steam and electricity which traces them back to the same source of energy—the sun. Photographs, old prints, diagrams, and sketches interpret the text. Boys of eleven years and over will be interested in this story of the development of mechanical power.

STEARNS, DAVID M. *Whisk; the Story of a Chipmunk.* Pictures by Sharon Stearns. Farrar, 1941. $1.00.

Natural history is in no way violated by this story of a chipmunk from his first day until his awakening in the spring after his first long sleep. For children eight to ten years old.

STRACK, LILLIAN H. *Radium.* Harper, 1941. $1.00.

Traces the history of the metal and describes methods of mining the ore and preparing it for the market. Many photographs. For children nine to twelve years old. (This is one title in a new series of books on American minerals. Others available are *Asbestos* and *Nickel.*)

TRUMPP, ELIZABETH A. *Every Child's Pet Book.* (Photographs by Carroll C. Snell.) Lothrop, 1941. $1.50.

An unusual book for the emphasis is on the choosing of a pet on the basis of the interest of the child so that the pet will be adapted to its owner and his home. For intermediate grades.

YATES, RAYMOND F. *The Boys' Book of Magnetism.* (Illustrated with photographs.) Harper, 1941. $2.00.

An introduction to the science of magnetism for grades five to eight. Includes many interesting experiments for the making of magnetic toys and games, the performance of magic by use of magnets, and so forth.

Zoo Book, Bird Book, Reptile Book. Whitman, 1941. 50¢ each.

Brief, factual material for young children. These may be used with science classes when materials are needed and funds do not provide for purchase of such titles as Ditmar's *The Book of Living Reptiles,* or the compilations of Federal Writers' Projects such as *Birds of the World* or *Who's Who in the Zoo.* For the intermediate grades.

THE 5-A'S STRIKE OIL AND SAW WOOD

Maud B. Lowen
Minnehaha School, Minneapolis, Minnesota

With the course of study before her the teacher regarded doubtfully the subject of the new unit—oil. Easy enough to study iron mining or wheat. The iron mines were no mystery to children whose alert parents included such additional side issues in a vacation trip up North. A suggestion from the school and weekend drives unrolled Minnesota wheatfields before children's eyes with samples of grain carefully brought back and designs of elevators made on the premises forming the basis for classroom exposition. In their own city some of the finest flour mills in the world were hospitably available for field trips. Oil was another matter.

They had more or less traveled east to New York, north to Canada, or west even as far as the Philippines, but oil regions seemed to have been on nobody's itinerary. It looked like a case of study the book and hope for the best. In a preliminary overview they planned five sub-topics, the last of which was uses of oil. It developed that, besides gasoline in motors, many of them were burning fuel oil in their homes. Questioned about its transportation, someone mentioned a pipe-line. Suddenly Roger arose and walked up front like a person in a vision, Roger to whom all three R's were equally and woefully difficult.

"I was down there," he said, "I don't know what state it was, I didn't see no oil wells, but I seen 'em laying a pipe-line."

The class leaned forward, breathlessly disregarding the grammatical errors, carried away. He talked rapidly, with gestures, pacing off the ditch, rounding his arms for the pipe size, sweeping them across the ditch to show the wood supports. He had his audience there with him, seeing the ditch caving in sometimes at points which his hands indicated, watching the joints made tight, the pipe finally lowered in sections, and the ditch filled in. Questions shot up and answers shot as quickly back. The whole incident ended with a sighing return to reality followed by a storm of applause.

At one moment he had put his hand into the sand table, using the sand to illustrate a point.

Now somebody said hesitantly, "We could build it there."

Ralph, the usually inattentive, became excited. "I've got an erector set, a pretty big one," he said. "I know how to build a drill. The book shows."

"I've got one, too—and I— and I," came various offers.

Within a few days the sand table bristled with derricks, Ralph's nearly three feet high. As their study covered the bibliography they had made, a railroad with tank cars was added and storage tanks. Ralph's drill had an electric motor that worked it perfectly except that it did not really drill. The class was vaguely dissatisfied and unearthed a toy handpump that had done yeoman service pumping water over dikes in a former reincarnation of the sand table as Holland. They tried it out; it pumped as well as ever—if you primed it. They worked it absently.

"If we had some oil," they said and "If we took the drill out," and "Do you s'pose oil would spoil the pump?"

"No, said the teacher firmly, "I've been hoping to get that squeak out of it for ages."

"But we'd need a well," they figured, "you can't get the sand all oil."

The shallow tub that had come with the pump was perfectly tight and leak proof. John brought a pint of discarded motor oil,

black and realistically smelly. It pumped even better than the water, needed less priming. They regarded the motor, they regarded the pump.

"Could we—do you suppose we could fasten the handle to the motor?"

"How?"

The answer to that question took days of thought and experiment. Absorbed groups hung around the sand table watching, suggesting, trying out ideas. They came early, with difficulty were pried loose at tardy bell for other lessons, with difficulty shooed out for recess or home. Boys from other rooms passed the door, stopped, were drawn in by the problem. Some junior high boys dropped in from a nearby school, as interested as any.

The motor must not get sand in it; the pump was too tall for the derrick. The whole motor equipment was boosted up on two chalk boxes. The pump went through a center floor opening; the "well" was set in the sand below. Now the handle had too little play; it struck the floor. Business of widening and lengthening the floor opening. John brought a smaller pump and motor and tried for two weeks to work it with a single sloping bar connecting the flywheel with the pump. Francis, Charles, and Roger, however, worked out a center post with a cross bar like a T that balanced teeter-wise. One end connected with the flywheel, the other with the pump handle. After a week they got it adjusted to work by hand. Then they tried electric current. Alas, the flywheel revolution was too small to give the pump a full stroke. An interested sixth grade teacher dropped in. She suggested fastening a bar across the flywheel in such a way as to increase its diameter. The boys adjusted it, fastened their T to it and behold, the stroke was sufficiently lengthened.

Now the power of the motor was insufficient for a complete revolution and stroke. The wheel stopped on dead center. Someone had to stand behind it and push it at the strategic moment to keep it revolving.

About this time another sixth grade teacher dropped in laughing and said,

"My boys and girls have been pestering me to know what you have done in here. May they come in and see?"

During that demonstration, no one knew quite how, some final slight adjustment happened. Slowly the flywheel began going around by itself. A full black stream of oil came more and more steadily from the pump as the piston traveled up and down. The well pumped on and on. Everybody became as excited as is usual on such occasions. At last the 5-A's had struck oil!

Now about this time the supervisor of science found out about it and, being the kind of person she was, even eleven miles of driving through a cold spell of a northern winter could not deter her from coming to see it. Regardless of the dangers from dripping oil, she crouched among enthusiastic "engineers," cleansing tissue in hand (the valve had stuck and the pump had to be pulled out and up-ended to shake it loose) while a demonstration was made before another fifth grade.

She announced that the supervisor of industrial arts ought to see it, too. Could it not remain till he came?

The children's faces fell. While the final problems of the oil well were being settled in the sand table the class had not been otherwise idle. A lumbering unit was in full swing. The oil well had been made to work, it had been interesting, it was finished. To have one's work noticed by supervisors was fun, of course, but they had planned no less than a combined camp and sawmill in the table. Their teacher had promised them that they could dismantle the oil well that very night. The supervisor was understanding. She would telephone industrial arts office at once. If they would just leave it till Monday morning—so they did.

Supervisors are busy folk. Industrial

arts was co-operating in defense work. Monday passed. Tuesday morning their teacher promised they might clear the sand table at noon, supervisor or no. Thirty minutes after noon he came—to survey an empty room and sand table. He left a charming and regretful message for the children. Thirty minutes later the sand table had acquired a cook shanty and bunk house while beneath it on the floor a committee was excitedly discussing the steady growth of a sawmill from John's erector set. Later Bonnie produced a lumberjack, having ruthlessly sheered her doll's hair to fit the character. Nora, a problem child, produced the best working peavey made with wire and a meat skewer. Jimmy, a pitiful last in most achievements, made the next best. Alice's father helped her to put hooks on the endless chain that bore the logs up to the mill from the mill pond. Carolyn dressed a cook because "the cook is important in a lumber camp." Bobsleighs, horses, flatcars and tracks, a crane, and a forest backdrop all appeared. Balsa wood was finally substituted for the log because of the dullness of the saw and the colt rather than horsepower of the motor. Before long the camp was well on the way to the point where a "tree" could be taken through a complete operation from felling to lumber right in the table.

For these two units at least half the class of all types of behavior and intelligence had brought appropriate material to school, most of it prepared at home, all of it outside of school hours. Those with nothing to bring had contributed labor and advice.

There is something about a concrete reproduction which one can handle that kindles the interest and imagination as nothing else does. The necessary substitutions do not seem to confuse the children's thinking. These youngsters knew that a real saw could cut more than balsa wood. To their principal's humorous suggestion that they were pumping colored water, they explained that they were using old engine oil because it was as near as they could get to crude oil. Some day when they visit an oil well or a sawmill it will have meaning for them that it would not otherwise have had. They can reason aptly now about making machinery solve the problem of moving heavy logs because they can visualize it. They see the value of utilizing the buoyancy of wood in water, of gravity in filling oil tanks and cars from a pipeline, of suction in pumping oil. They explain how iced roads in winter, by reducing friction of heavy loads, give winter logging an advantage over summer logging. They know the advantage of floating logs downstream instead of shipping them by train or truck; they tried it out. All of them do not know all of this, but most of them know much of it.

A sand table vitalizes a unit so that reading is done with zest. Construction gives such content and familiarity to the vocabulary requisite to a new unit that nearly non-readers find their references vivid with meaning and therefore readable. This class made bibliographies of available room material, not only locating it from index and contents, but allocating it by topics to the various student groups. They consulted public libraries, home encyclopedia, current newspapers and magazines, and their friends and relations. They divided into groups, each choosing one phase of the unit, and studied preparatory to presenting it to the class as a whole. This research, you may think, is exactly what all fifth grades do and are supposed to do but in this case they proceeded with independence and initiative requiring little from the teacher except comradely advice and interest. Like a little logging train they were pushing their unit ahead of them. They were, of their own volition, reading to learn.

There is no better solution of school behavior problems than a genuine interest in a school subject. Absorbed children work with such ease and freedom that enough

organization to point to the next step is usually all that is necessary.

Parents, too, are interested because when a child is really kindled, he becomes a center of enthusiasm which radiates wherever he goes. When parents become interested they help and they find fun doing it. The value of this happy collaboration lies in fusing the interest of home and school in the child's development. This cannot be overestimated. You not only get better equipment for your sand table, such as a two and a half inch cross-cut saw that will really saw from a son whose father knows about saws, but Daddy is likely to take a quickened interest also in Son's fractions or spelling ability or even his propensity for getting into fights on the playground. This may lead to the recognition of Son's inability to get along with other children as a problem with a bearing upon his future success in getting along with his fellow workers.

Thus the sand table not only promotes interest in social study units by visualization, introduces elements of scientific principles, stimulates reading ability, correlates with other school subjects such as art and language, encourages ingenuity, initiative and perseverance, but now and then furnishes a means of co-operation with the home in correcting defects of personality.

A FIRST INTRODUCTION TO ASTRONOMY

AGNES M. ANDERSON

First Grade, Bremer School, Minneapolis, Minnesota

One morning during our "News Time" Janice reported, "Last night we went away. When we came home it was late, but it was light outside." Out of this little bit of news grew the most interesting science experiences I have ever had with children.

Questions rapidly followed Janice's story. "What made it so light?" "Why doesn't the moon make it light every night?" "How did the moon look?"

As Janice drew the full moon on the blackboard a child asked, "Does the moon always look like that?"

When the teacher asked how many of the children had seen the moon the night before only one other child responded. She said that "it had shown through her window."

Again the evening brought the full moon and a brilliantly lighted sky. "News Time" at school the next morning brought much evidence of interest in the moon. The children could scarcely await their turn to tell that they too had seen this wonderfully bright and full moon. They also told in what part of the sky they had seen it. Their eyes were bright, their faces eager, their bodies responded with gesture and buoyancy. Many questions about the moon were raised. Some were answered. Others were left for further observation and discussion.

Carol's story gave her proof that she had made a real discovery when she saw the moon in the morning sky. "Last night when I went to bed I saw the moon through my bedroom window. When I went into Mother's room in the morning I saw the moon from her window. It was on the other side of the house."

In the same eager manner interest and observation went to the stars. The parents too learned as they went out at night with their children to see the North Star, Casseopia, Orion and other constellations.

Joy was complete when nature put on an eclipse for us. Scarcely a child missed seeing it.

Mary Lou reported, "Last night after I

had gone to bed Daddy came up and took me downstairs to see the moon. It looked different. It was partly covered and it looked orange. It was an eclipse."

Some children brought pictures of the eclipse cut from the morning newspapers. They brought atlases and books of all descriptions containing anything of interest they could find on the subject.

We learned about the phases of the moon by keeping a record on our calendar. A full moon was cut from silver paper and pasted on the date it appeared. The same activities were carried out with the new or crescent moon and the quarter moon. So we learned by actual observation and record that there is a full moon once a month and a new moon once a month and that the new moon changes into the quarter moon as the nights come and go.

The children enjoyed sharing their delightful experiences with others by illustrating their learnings on the bulletin board in the hall. Their exhibit was in three sections on a background of black paper with the heading "The Sky at Night." The center section showed a picture of the children at bedtime looking out at the stars. Under the picture was the poem "Twinkle, Twinkle, Little Star." On the next section silver stars were pasted to represent some of the constellations. Below this was a typewritten sheet giving some of the facts learned.

Do You Know That?

The stars are always in the sky.
You can see them only on a clear night.
The stars are very large.
They are very far away.
Some light comes from the stars.
Some stars make pictures in the sky.
The Big Dipper is made of seven stars.
It is always near the North Star.
In autumn it is right side up.
In spring it is upside down.

On the other section were the four phases of the moon cut from silver paper with these facts below:

Do You Know That?

The moon is not always in the sky.
You can see the moon only on a clear night.
Sometimes the moon is not in the night sky.
Sometimes it can be seen in the day sky.
The moon gives light.
Moonlight is not warm.
The moon rises in the east.
It goes down in the west.
There was a full moon on February first.
There was a new moon on February fifteenth.
There is a new moon once a month.
There is a full moon once a month.

Obviously we did not carry our study of astronomy very far. It was not my purpose to teach many facts but to arouse interest in the wonders of the universe. I have learned not to be afraid of science in the first grade for the children show by their interest and enthusiasm how far they can go. I earnestly believe that the moon and stars in the clear night sky will have a special thrill and meaning to many of these children as long as they live.

ELEMENTARY SCIENCE COURSE OF STUDY FOR INTERMEDIATE GRADES

ILLA PODENDORF

Newton Public Schools, Newton, Iowa

It has been the opportunity of the writer to teach or supervise science through grades three, four, five and six of the public schools of Newton, Iowa, over a several-year period. During that time the greatest problem has been the selection and organization of teaching materials best fitted for each grade level. As a result there has been much shifting, elimination, and reorganization of subject matter.

This is an attempt to present and discuss the development of the course of study which is in use at the present time. The major objectives for science teaching, the

subject matter which aids in attaining the objectives, and some of the changes made are considered here. Included is also a list of the units now being used.

The objectives have been revised several times to give less stress to content and greater emphasis to the development of understandings and appreciations. The general objectives orient directly into the seven cardinal principles of education. The objectives listed below are those being used at the present time:

1. To develop an appreciation of the need for health and ways of maintaining it;
2. To make an exploration of interests and aptitudes in fields of science;
3. To develop a questioning interest in the environment with an ability to make correct observations and evaluations;
4. To develop self-assurance and skills in interpretation of the environment;
5. To develop a wholesome and workable philosophy of life;
6. To meet the needs of children in personal, social and community relationship;
7. To develop desirable habits of thinking and freedom from superstition;
8. To develop an appreciation of natural beauty and an attitude of conservation;
9. To develop a worthy use of leisure time;
10. To develop an appreciation of the work of scientists and people before us.

These general objectives are broken down into more specific objectives for each teaching unit.

The subject matter is organized on a "unit plan" basis although the units are not true units in the sense that Morrison used the term. The unit functions as a complete and independent group of learnings that have a direct bearing on the general objectives. The teaching unit outline includes teacher objectives, suggested learnings, suggested activities, and teacher and pupil references. This particular plan was used, and has proved to be satisfactory, mainly because teachers can follow the course of study and at the same time use initiative in developing it. For example, the material may be developed as part of a true unit, correlated with another subject, or used as part of an activity program. Secondly, it gives what is believed should be taught at each grade level with teacher objectives and suggestions for teaching. In the third place, if reference material is limited, or very scattered, more of the actual subject matter can be presented with the suggested learnings and thus simplify it for the teacher.

Many units have been used in grades other than those indicated in the present course of study. Changes were made primarily on the basis of pupil comprehension of, and interest in, the subject matter. The discussion which follows shows the reasons for and nature of some of the changes which have been made by this "trial and error" method.

A unit on snakes was taught in the sixth grade for two consecutive years. The pupils had no difficulty with the subject matter. The sixth-grade boys were much more interested in this unit than the girls. It seemed difficult to break down the feeling of aversion toward snakes which many sixth-grade girls had. Because of this, the unit was moved to the fourth grade. In this grade the children were again extremely interested in the subject matter. It soon became evident that fourth-grade pupils lacked the maturity which was necessary to form judgments concerning poisonous and non-poisonous snakes and were easily carried away by their enthusiasm. The unit was finally moved to the fifth grade where it has been offered for the past seven years. The science teachers generally agree that the material is well suited for this grade level.

A unit on "Man's Use of Rocks and Minerals and How They Were Formed" was presented in the fifth-grade classes for two years. The subject matter was suitable for this grade but two different major interests developed. The younger and the less mature pupils were especially interested in collecting and in identifying rocks and minerals, and the older pupils were more interested in the study of how rocks and minerals were formed. The teachers believed that the reason for this difference

in interest lay in the fact that the unit covered too large an area. The material was then divided into two units: "How Man Uses Rocks and Minerals from the Earth," which was given in the fourth grade, and "Rocks and How Formed," which was given in the sixth grade. This arrangement proved to be more satisfactory. The sixth-grade unit has been enlarged to include a study of soil formation, coal, and petroleum. The name of the unit now reads "How the Earth's Crust Has Changed."

During the first four or five years the process of photosynthesis was not included in the Newton course of study. The fourth-grade unit on "Trees" stressed the food-manufacturing function of leaves. Because the children asked more about the process, an attempt was made to actually teach photosynthesis. Two teachers used the unit and felt that it was a failure. A second year they taught it again by comparing photosynthesis to a concrete manufacturing process. There was much class interest but the teachers believed that the pupils learned very little. Photosynthesis was then moved to the sixth grade. The pupils were interested and gave evidence of understanding the fundamentals of the process. The teachers now agree that the material is well suited for this grade level.

Electricity was included in the first outlines prepared for grade five. The unit included positive and negative charges, laws of poles, conductors, batteries, detectors, *etcetera*. This was followed up by work on radio in the sixth grade. The teachers believed this to be too hard for that grade level. The work on electricity was moved to the sixth grade and the work on radio omitted entirely. In addition, material on ohms, amperes, and volts was included. This unit was presented two consecutive years. These concepts were too difficult for sixth-grade pupils. The unit was then rewritten to include only positive and negative charges, laws of poles, parallel and series connections, live wires, insulation, and uses of electricity. It was still too difficult. Now, electricity is included in a unit "How Science Explains Common Things." The emphasis is upon the use man makes of it. Work on electromagnets, where we get electricity, fuses, insulation, complete circuits, and first aid is included in the unit. The teachers are now satisfied with the subject matter as it is outlined for the sixth grade.

Following is a list of units suggested for each grade level. These suggestions are made on the basis of the "trial and error" method of selection previously described. In addition to this each unit has been carefully justified on the basis of the major objectives. A very definite attempt has also been made to keep the units environmental and seasonal.

Third Grade Units

1. How to Know Common Moths and Butterflies;
2. How Some Animals Are Able to Live in Ponds and Aquaria;
3. How Plants and Animals Get Ready for Winter;
4. How to Care for Animal Friends;
5. How People Have Lighted Their Homes;
6. How Magnets Work and the Use Man Makes of Them;
7. How We See in the Winter Sky at Night;
8. What Happens in Spring;
9. How to Know Some of the Common Birds When We See Them;
10. How to Know and Preserve Wild Flowers.

Fourth Grade Units

1. How Some of the Most Common Insects Live;
2. How Some Animals Without Backbones Live;
3. How Man is Dependent Upon Plants;
4. How Man Uses Rocks and Minerals From the Earth;
5. How Man Depends Upon Plants and Animals for Clothing;
6. How Some Mammals Take Care of Themselves and Their Young;
7. How the Sun and Moon Affect Man;
8. How Air Works for Man;
9. How Birds Make and Care for Their Homes;
10. How Trees Change in the Spring.

Fifth Grade Units

1. How Weeds Are Harmful to Man;
2. How Some Snakes Are Helpful on the Farm;

3. How Many Living Things Build Homes and Protect Themselves;
4. How to Identify Trees in Winter Time;
5. How Some Animals Live in Large Bodies of Water;
6. How Some Birds Migrate;
7. How to Preserve Wild Life and Natural Beauty;
8. How Plants Are Adapted to Reproduce.

Sixth Grade Units

1. How Trees Are Important to Man;
2. How the Earth's Crust Has Changed;
3. How Plants and Animals Have Changed;
4. How Dependent Plants and Animals Affect Other Plants and Animals;
5. How Science Explains Common Things;
6. How the Earth Is Related to the Universe;
7. How Birds Are Adapted to Their Life;
8. How Some Insects Are of Economic Importance to Man.

It will be noticed there is a definite sequence in the organization of subject matter from grade to grade. That is units are chosen from the large areas of subject matter in such a way that other units may draw material from the same large area. This gives opportunity for review and reteaching. For example, magnetism is taught in third grade in "How Magnets Work and the Use Man Makes of Them" and again in sixth grade in "How Science Explains Common Things."

It is intended that this course of study be used only as a guide in the selection of subject matter. Each teacher must use her initiative in her own situation. Individual class abilities and interests must be an important determining factor.

CONSTRUCTION AND TEACHING OF A UNIT ON SOUND IN THE THIRD GRADE

M. ELIZABETH MORRIS

Third Grade Teacher, Sanford B. Ladd School, Kansas City, Missouri

Children love sound and find it a means of self-expression; it is a part of their lives. They frequently ask such questions as: "Will it make a noise?" "How does it make a noise?" "What was that noise?" When questions such as these are asked often by primary children we may be sure they are asking for an adequate and satisfying explanation of a puzzling phenomenon. This unit was intended, therefore, to extend the children's experiences and thus aid in making their environment more meaningful.

Through experimenting with concrete objects, reading factual material, and discussing experiences, the elements of learning basic to an understanding of "What Makes Sound?" were developed.

The unit was organized for teaching into the following three problems with their sub-problems:

I. What is the origin of sound?
   A. Why do certain words remind us of particular sounds?
   B. What is vibration?
   C. Are all sounds caused by vibration?
   D. How can we produce different sounds?

II. What causes pleasant and unpleasant sounds?
   A. What is the difference between a pleasing sound and noise?
   B. How can we produce pleasing, musical sounds?

III. How are sounds carried?
   A. How do vibrations which cause sounds get to our ears?
   B. Can a solid carry sound?
   C. Can a liquid carry sound?
   D. What causes echoes?
   E. Can sounds be guided or directed?
   F. Can a place be found where there is no sound?

The approach was that of focusing the children's attention to sounds in the environment. The following excerpts from the log of the unit will indicate techniques used to establish each of the learnings:

Problem One: What is the origin of sound?

Approach

One afternoon, toward the close of the children's usual rest period, a heavy weight was dropped to the floor, which startled them. Their curiosity was immediately aroused and the following conversation between teacher and pupils took place:

"What was that?"

"What do you think it was?"

"You dropped something heavy."

"How do you know it was heavy?"

"I could tell by the way it sounded?" was one child's quick reply.

As other sounds were made the children were quick to recognize each.

"We are always hearing all kinds of sounds. They tell us what is going on round about us," remarked the teacher. "Listen! Close your eyes, get very still." (A pin was dropped on the desk.)

"I heard a pin drop," came the unanimous chorus.

The children had a great deal of fun, then, discussing the question, "What is sound?" For instance, one child's surprising explanation was:

"When anything hits it vibrates and the sound is thrown like a flash through the air."

Another child wanted to know what was meant by 'vibrates.' The explanation given was:

"It's when anything goes back and forth real fast, like the gear shift on a car makes your hand shake when you touch it."

This response stimulated other children to relate their experiences with vibration:

"When a fire truck goes past my house it shakes our windows and makes them rattle."

"When the motor starts on the refrigerator it makes things go back and forth."

The children were then shown the objects which they had already attempted to identify by sound a few minutes before.

"Here are the things you heard make a noise a few moments ago. Why couldn't you see the noise?" asked the teacher.

"It went through the air so fast we couldn't see it," was given in answer.

"Yes," said the teacher, "we can say that sound is invisible."

"I know how the sounds get to our ears," volunteered a boy.

"How?"

"The wind carries sounds to our ears and our ear drum catches them."

Then, another child offered his explanation:

"It's natural that when a chain falls it makes wind; wind gets behind noise and pushes it."

The above quotations are indicative of children's attempts to interpret their environment. During the discussion period, questions were raised by individuals and others attempted to answer them. The summary which follows indicates that much intelligent thinking was stimulated:

"What makes all the sounds we hear?"

"Something moves."

"How does sound turn?"

"It's like a cloud of smoke; it can go in all directions."

"Can sound go through the ground?"

"Why, yes. Don't you remember how the Indians put their ears to the ground to hear if anyone was coming?"

"Why are some sounds louder than others?"

"Some things are bigger than others, that's all."

"Listen!" (The window was raised to make the sounds clearer. The scream of a fire truck whistle was heard in the distance. A train whistle was heard afar off. Motor cars were honking by.)

"When we listen, sounds tell us many things," remarked the teacher. "Wouldn't it be fun to keep a list of all the sounds we hear about our homes this evening!"

The next morning the children presented long lists of "Sounds About Us" which indicated increasing alertness to sounds in the environment.

Sub-Problem One: Why do certain words remind us of particular sounds?

As the lists are read the children discovered that certain words such as crackle, tinkle, thump, and pop simulated the sounds which they were describing. From this discussion the children formulated a table of words meant to be like sounds.

At this point a little book, *Sound and Noise,*[1] was discovered by the children and since the first chapter was about listening and naming sounds, they were anxious to read it to see how it compared with their experiences.

Sub-Problem Two: What is vibration?

The next three chapters of the book were "To and Fro,"[2] "Timing a Pendulum,"[3] and "Very Quick Movements."[4] These chapters helped to clarify the meaning of the term "vibration." The class spent the next two days making pendulums and using them in their experiments.

"'Vibrations' is a rather long word, but it is a very useful one," explained the teacher. "It is the word used for the little to-and-fro movements we have been talking about. Vibrations are regular, steady, even movements to and fro. Some things move to and fro very quickly, more quickly than even the shortest pendulum we made, so fast that we cannot see them move but we can hear them."

Experimenting with the pendulum helped the children to understand the principle that tones are dependent upon the number of vibrations per minute.

Sub-Problem Three: Are all sounds caused by vibration?

The children were then asked to bring something to class that would make a sound. A number of days were spent in experimenting with the many things that were brought into the classroom and many experiments were performed

[1] McKay, Herbert. *First Steps in Science, Book 2, Sound and Noise.* London: Oxford University Press, Humphrey Milford, 1929.

[2] *Ibid*, Chapter II.

[3] *Ibid*, Chapter III.

[4] *Ibid*, Chapter IV.

to determine just what happens to make them produce sounds. For example, by filling eight long test tubes with varying amounts of water and blowing across them the pupils discovered for themselves how wind instruments produce sounds. Another experiment was performed to show how shortening and lengthening a column of air effects sound.

A good illustration of vibration in percussion instruments was shown by sprinkling bits of cork on a drum-head and watching them jump around when the drum was struck, causing the membrane to vibrate.

The very simple example of stretching rubber bands across a small block of wood with a pencil or similar object for a bridge pictured for the children the way in which stringed instruments produce sounds.

Experimentation was carried further through the use of the tuning-fork. These discoveries were made by the children:

Each fork gave the same hum every time it was struck.

They could feel a jar by touching one of the prongs to their teeth.

If one prong were struck, it started the other moving to and fro, also.

The sound could be made louder by holding the stem of the fork on the table after striking it.

They could feel the little to and fro movements or vibration by holding their fingers close to the prongs.

The quick movements of the fork set in motion would make a cork that had been fastened to a nail by a fine thread fly off when touched by one of the prongs.

Sub-Problem Four: How can we produce different sounds?

The group discused the value of a fork that always gives the same hum and made an interesting experiment with the piano. The class listened to the notes of the tuning forks and found their corresponding tones on the piano. It always gives the same hum; therefore, the same note is heard.

We observed the inner mechanism of the piano as we played the notes. These comments show a growing understanding:

"The little hammer hits the wire and starts it vibrating."

"The fat strings made low sounds and the thin strings made high sounds."

A difference in the thickness of the strings was noted and this observation led the children to discuss how they could change sounds. A toy sonometer constructed by the children showed them how a string begins to move up and down very quickly when plucked and gives a hum; that each time the string is plucked, one hears the same hum; that the shorter the string the higher the hum. The teacher explained that the shorter string is like the shorter pendulum. It vibrates more quickly and so gives a higher hum.

A sonometer from the physics laboratory was brought in and the children experimented with the thick wire and the thin wire to hear the different tones. By using a bridge they could vary the lengths of the wires and change the sound. They proved over and over for themselves that a tone can be changed by shortening or lengthening the string.

Problem Two: What causes pleasant and unpleasant sounds?

Sub-Problem One: What is the difference between a pleasing sound and noise?

One day a child brought a can of rocks to school. The teacher used this opportunity to develop the difference between pleasant and unpleasant sounds. She explained, "Some of the vibrations are quick and some are slower, depending upon how the stones hit. There is a jumble of noises because the stones hit in all sorts of ways."

"When the piano is played, or the tuning-fork is set vibrating or the strings of the toy sonometer are plucked, the sound they make is pleasant because the vibrations they set up are not broken and so make regular waves."

Photographic representations of a musical tone and of a noise were shown to the group.

Spontaneous remarks similar to this one surely portray an elementary understanding:

"A smooth sound goes evenly through the air, a rough sound looks like the top of a city."

Sub-Problem Two: How can we produce pleasing musical sounds?

Several musical toys such as musical bottles, flower-pot chimes, a "xylaboard," drums, and an "acquacyl" were made by the children which showed them that in order to get a musical note they needed to find a way of getting a clear set of vibrations.

The difference between music and noise was summarized in these two children's expressions:

"Music is a pattern but noise is a conglomeration of sounds."

"In music we hear clear tones; noise is just a jumble of sounds."

Problem Three: How are sounds carried?

The different aspects of this problem were developed in a manner similar to that described in the preceding problems.

In an analysis of the log of the unit it was revealed that the following learnings resulted from the development of the three problems of the unit:

1. Vibrations are little to and fro movements.
2. A sound is made when air is set in motion.
3. Any vibration in air causes sound waves.
4. All sounds are made by some object vibrating.
5. Sound waves close together made a high tone.

6. Sound waves far apart make a low tone.
7. The larger the vibrating object, the louder the sound.
8. The same thing may make different sounds.
9. A sound wave cannot be seen.
10. There are many sounds not heard by people.
11. Regular waves produce pleasant or musical sounds.
12. Irregular waves produce unpleasant sounds or noise.
13. A short string gives a high pitch.
14. A long string gives a low pitch.
15. A thin string produces a high pitch.
16. A heavy string produces a low pitch.
17. Vibrations traveling toward us are heard as sounds.
18. Vibrating objects set up successive vibrations, or a train of waves, which continue until they reach our ears and are heard as sounds.
19. There is no sound in a vacuum.
20. Sound can be directed or guided.
21. Sound waves move in every direction.
22. Sound takes time to travel.
23. Sound does not travel so fast as light.
24. Sound can be carried through solids, liquids, and air.
25. Sound travels fastest through solids.
26. Sound travels faster through liquids than through air.
27. Echoes are reflected sounds.

The children's reports of out-of-school experiences, their discussions, and the informal tests, administered at intervals, support the following statements:

1. An understanding of facts concerning sound can be developed by third-grade children.
2. Certain facts and principles in a sound unit can be presented to third grade children.
3. A concept of sound aids children in interpreting their surroundings.
4. Children become very conscious of the sounds in their environment after their attention has been focused on them.
5. Children can be led to use science material in their out-of-school activities.
6. An early foundation of general scientific knowledge can be an important means of increasing the significance of later study.
7. An understanding of the concept of sound leads to interest in onomatopoetic words such as crashing, creaking, and twittering.
8. The unit contributed to vocabulary development.
9. Children can be interested in experimenting to discover facts.

The following recommendations are made:

1. The place of sound in the science curriculum of the primary grades is indicated by children's interest in the subject. Experience in teaching the sound unit provides further evidence of children's active interest in this field of scientific knowledge.

2. This unit does not aim to train physicists. Rather it purposes to give to children a basis of knowledge which will enable them to interpret more accurately and appreciate more intelligently one more aspect of their environment.

3. In order to teach the unit as it is here presented, at least three periods per week for six weeks should be devoted to science.

4. An adequate amount and type of reference material is imperative for the successful development of the unit on sound.

5. It is recommended that this unit be taught at the third grade level.

6. It is felt that this unit may easily be taught by the room teacher. More meaningful correlations with other subjects are possible if the regular room teacher is responsible for the science instruction. Correlations should be natural outgrowths of the regular activities of science. Care should be taken to make all correlations a necessary part of the science work.

7. Visual aids occupy a role of major importance in the development of understandings in this unit. The necessary materials are relatively easy to obtain, and each teacher should avail herself of every opportunity to give reality to basic science understandings. This unit lends itself well to the use of concrete objects which are of great value in giving reality to scientific concepts.

Editorials and Educational News

ELEMENTARY SCIENCE IN WARTIME

In a time of extreme crisis, such as the present, the teaching of science takes on more than its customary importance. The attention of warring nations is focused upon science as probably never before. The belligerents look to science to furnish the primary means both of offense and of defense. Success or failure in applying scientific knowledge effectively is likely to shift the balance toward victory or defeat. In total warfare, in which remote hamlets may at any moment become parts of the firing line, and in which civilians far from the actual combat zones may share with the armed forces the dangers of agony and sudden death, scientific knowledge as part of the equipment of everybody becomes of paramount importance. Children, as well as adults need to be given definite scientific training in order that they may be able to make definite practical contributions to the total war effort on which survival depends.

Prominent among the areas which may well be stressed in the elementary-science program are food and diet, conservation, personal and community health, safety and first aid. Cooperation in the elimination of waste and in the prevention of the loss of foods and other valuable essentials can be secured only when children, as well as their parents, possess the scientific knowledge upon which such phases of conservation are based. A scientific knowledge of balanced diet, food substitutes, sanitation, and personal and community hygiene are or may soon become of grim significance to all but the very young as well as to the old. The ability to provide and secure safety from wartime hazards become matters of immediate and primary importance to everybody, irrespective of age or socio-economic conditions. All these and other aspects of science become essential parts of the work of the elementary school.

In such an emergency as the present one, the elementary teacher is subjected to many influences which tend to cause her to construct units and to institute activities of science which are based chiefly, if not wholly, upon immediate and imminent "practical" considerations. She is encouraged to teach as quickly and as effectively as possible the facts and skills dealing with present and possible future emergencies related to the preservation of life. She is influenced to place primary emphasis upon *what* and *how*, rather than upon *why*. Consequently the memorization of facts and skills is likely to become the primary, if not the only, goal of work in elementary science; reflective thinking is likely to become more or less an incidental or an accidental part of the course.

Contrary to common opinion and in contrast with common practices, the pressing urges of wartime should provide a means to a broader rather than a narrower teaching. The stress of conflict which the children must inevitably experience, vicariously if not actually, provides an unusually strong and effective motivation for work in science. Such motivation sustains the children's efforts to learn scientific content which may now or later contribute substantially toward winning the war and toward winning through the post-war period. Activities and materials must be determined with unusual care. It is essential, of course, that the children emerge from their study of the various units with an effective command of the desired special factual knowledges and skills. But these facts and skills, important as they unquestionably are, should not be final ends in themselves. They should be made the means of promoting the broader objectives of science teaching. Facts should be made to contribute to an understanding of those important principles of science which underlie the content of elementary science and which are selected as being especially appropriate for children in wartime. Thus while pupils are learning what they should eat, how to grow foods, how to maintain proper sanitation, and (the older ones, at least) how to apply first aid, they should also learn the underlying reasons why the practices advocated and taught are sound. They should be led beyond the mere facts and skills to both an understanding and a reasonable facility in the use of such elements of scientific method as raising problems, proposing ways to solve them, gathering data leading to their solution, making good and testing inferences, and all the rest. While the children are gaining the essential wartime knowledges and skills they should also be making progress toward the acquiring of such scientific attitudes as the willingness to weigh and evaluate facts, the willingness to listen with an open mind to the ideas and opinions of others, the willingness to resist the temptation to leap to conclusions not supported by facts, the unwillingness to repeat rumors and other statements not supported by facts, and the like. In other words, the ultimate objectives of elementary science remain the same in wartime as in peacetime; only the activities and materials contributing to these ultimate objectives change in ways appropriate to existing and potential emergencies.

If elementary teachers in developing work in science keep clearly before themselves such important objectives of science teaching as developing ability and skill in reflective thinking, inculcating scientific attitudes, and effecting a broadening understanding of scientific principles, then the activities appropriate to wartime can be made to contribute substantially and constructively to whatever needs may now or later arise.

FRANCIS D. CURTIS
University of Michigan.

SCIENCE IN RELATION TO THE CHILD AND HIS COMMUNITY

One of our greatest concerns today is the education of our young children, those youngest participators in the affairs of any community.

It is only recently that educators have realized that the school life of a child is only a part of his whole life. The school is beginning to reach out to give service to the total community, and is in turn beginning to value the service which the community might give to it. We are at last accepting and using the contributions of greengrocers, florists, railwaymen, telegraphers, policemen, doctors, postmen, street-cleaners and parents. We have been very slow to recognize the fact that they can help in the education of children. This has not been true of children. They have been wiser than we.

Children have always lived in the larger community. Children have always learned from the community. Children have been slow to bring the community into the classroom, probably because we have only put the school in the community, and have done little to make it a part of the community.

A consideration of possible experiences from the two areas "Conditions Necessary to Life" and "Living Things" gives evidence that we can do much to help a young child understand his environment. What things are necessary for the successful growth of plants? Do animals need the same growth conditions as plants? Furthermore, do all animals live well under the same conditions? These questions may be investigated by children with the help of a classroom teacher. Emphasis is to be placed on the word investigate, since it is real investigation and not mere reading about a question that is necessary. Young children learn much from walks around their community at various times during the year in order to notice the growth of plants at a time when there is ample water, light and heat and at a time when there is less light and heat and little except frozen water. They learn much as they care for animals at school and in their homes. How are baby mice cared for so that they will grow up to be strong and healthy? How can a puppy be kept clean and lively? What do human babies need for proper growth? How can children help to care for themselves so that they will grow up to be strong, healthy men and women? In solving such problems, various experiences should be used such as reading for facts, carrying on experiments, asking questions of and checking with community authorities on such matters.

Materials from the area which we might call "Physical and Chemical Forces" also aid in enlarging a child's background and understanding. Experiences dealing with magnetism and electricity may be understood by both six and eleven year olds. The very young child may use a magnet merely as a toy at first. Later he begins to experiment with it. What things will a magnet pick up—a small metal automobile, a piece of crayon, a paper clip, a thumbtack? Then he may decide that a magnet attracts metallic objects. Later he may refine his experimenting by testing only metal objects such as dimes, pennies, nickels, paper clips, thumbtacks and nails. The conclusion does not have to be taught to children, nor do they have to read it from a book. They live through an experience and come to a conclusion. A later and very necessary step is the checking of the conclusion with some reliable source, either a book or an authority in the field.

The older child is capable of further progress in the field of magnetism and electricity. He is able to experiment with making electric circuits. He finds that they must be complete. He discovers which things conduct and which do not conduct electricity. He learns how electromagnets are used in the telegraph, the telephone and the radio. Most children who have been allowed to work freely with such materials are fascinated by them. In addition to the valuable experience of being able to work out a problem, they also begin to appreciate the contributions of many people to society. A cultured teacher will be able to lead children toward a fuller appreciation of the ways in which radios, telegraphs and telephones are used by the community. Where are the instruments made; how many people aid in their daily operation? It would probably be unwise to try to point out the relationship of science to society at every point. But it is desirable that children better understand the community contributions of as many people as possible.

A real understanding of some of the sun-earth-moon relationships also is of assistance in gaining an understanding of the total community. We must place ourselves as members, not only of our village or city community but of our world and solar system community. How is it that the moon and sun can materially affect shipping? What does the sun have to do with the change of seasons, with day and night? Perhaps a more complete knowledge of our environment would give us a more real feeling of belonging to it and of being, in part, responsible for the best use of it.

Perhaps the most important science-community relationships may be pointed out in a study of the earth and its resources and the control of these resources. A voting citizen should understand the natural resources of this country. He might well begin to gain this understanding as a child. What is oil; what is coal? Will the oil supply last much longer; what about the coal supply? Why cannot they be replenished? Does top-soil form quickly, or does it take hundreds of years for a six-inch layer to be formed? These are only a few of the vital questions about which our present six-year-olds must hold an opinion in some fifteen years. Our eleven-year-olds should have the facts with which to form their opinion in ten more years.

It would appear that we are not only losing sight of interesting science experiences, but are actually failing to do our part as contributing members of a democracy when we fail to give our children access to the facts about our country.

There is another relationship between science and society that is probably even more fundamental. Science can contribute to society by pointing out a way of thinking. A person who thinks scientifically in regard to a social question thinks without prejudice. He gathers his evidence, considers his facts, draws his conclusion and checks that conclusion as carefully as possible. Children are not born with the ability to solve problems in this manner. They need much experience in this field.

Finally, we must fully understand this fact which science shows us—that we can never be isolated from the larger world community. The prevailing winds know no national boundaries, neither do disease organisms. The world is a community, and we are a vital part of it.

By helping young children to solve problems in the best way possible, by helping young children from the very beginning to feel that they are real and functioning members of their immediate community, perhaps they and we may be able to evolve a better world community.

KATHERINE E. HILL
Department of Natural Sciences,
Wheelock College,
Boston, Massachusetts.

SCIENTIFIC ATTITUDE

A scientist is slow to accept as fact such statements as are not supported by convincing evidence, he respects another's point of view, changes his conclusions in the face of newer, more conclusive evidence and seeks to understand the principles underlying the things he observes. So, too, should the citizens in our democracy. The boys and girls who today are in science classes in elementary and high school are the individuals who will tomorrow be the administrators of our national policy, the governors of our states, the mayors of our cities, and our voters. True, that is not a new idea but it places in the hands of the science teachers great responsibility. Much greater than they have to date been able to cope with.

Much glib talk about scientific thinking and too little actual practice in exercising such thinking has been our weakness. Perhaps it is not possible to instill a scientific habit of thinking into the mind of a boy or girl. Has any school system actually tried consistently to do so from the primary grades through the last year in high school? Certainly children do not absorb such an attitude by reading about it in the preface of the text, by following a set of directions for doing an experiment or filling in blanks in a work book. How then do they attain such an attitude? Certainly we can be safe in saying that one way is by being *forced to exercise such an attitude day after day.*

Experience shows that the more real the problems are which boys and girls are attempting to solve, the more earnestly they attempt to solve them. Some of the problems relating to the war are excellent problems for science classes. Pupils all over the country are collecting paper, collecting tin, conserving sugar and engaging in dozens of other similar activities. If asked *why*, it is very likely that a high percentage of them would actually know little to answer.

If asked to investigate these problems a large majority would believe the first person who gave them information. The question of *who* gives the information appears important only to a small percentage of our pupils. The fact that sources disagree may not even stimulate them to do further investigation unless they are led to do so. It occurs to few individuals to evaluate sources of information. Why? Could it be because we have not continually urged and required them to do so?

The great nation of America is at war. This fact affects every child in our schools in one way or another. The problems concerning the war are real. Under direction the solving of some of the problems can call from pupils the best they can offer in thinking.

Can it be that this is an opportunity for departing from the course of study into solving problems of immediate concern to pupils? Is it a time for placing more stress on the validity of the source of information than on the remembering of unimportant details of facts—a time for stressing the importance of being open minded—a time for learning to analyze data carefully and accurately?

Day after day, week after week, year after year, through our science classes there must be constant stress on the elements that go to make up a scientific way of looking at things. A justification for some of the science subject matter we teach is difficult. The development of a truly scientific attitude is in itself a justification for any number of hours spent in the science classes of our schools.

GLENN O. BLOUGH,
Laboratory School,
University of Chicago.

SCIENCE EXPERIENCES AND DEMOCRATIC LIVING

The purpose of science education today is to give the child some understanding of the basic concepts of science so that he may learn to adjust himself to his environment, to make wise use of the factors within his environment, and to develop into a successful, intelligent and useful citizen. In other words, the purpose of science education today is simply what should be the purpose of ALL education. Science is merely one of the great, universal tools by which the child today may be guided into a richer and more abundant life.

Every child is born with an innate interest in those things which exist in his immediate en-

vironment, especially those things which lie in the field of science. This interest develops in a definite manner as the child develops and is evidenced by the specific nature of the questions which he asks. There is probably no other field in the elementary school program where there is so much vital interest, on the part of the child, WAITING to be developed, than there is in the field of science. It is the wise teacher who recognizes this fact and makes the most of the opportunities offered. It is also the wise teacher who recognizes and understands the various levels of interest among children and who utilizes the things of science to enrich the experiences of the boys and girls who come under her guidance. The teacher who fails to take advantage of these opportunities fails society.

Society today is in a confused and chaotic condition. Avarice, greed, corrupt politics and a lack of understanding among peoples are blamed, but only in part. Educators should have recognized LONG AGO that science is an universal tool. Teachers should have been trained in the use of the scientific method. Children should have been taught to think scientifically. Instead, the scientific method, the way of scientific thinking, and the things of science have been shunned as something strange, mysterious and comprehensive only to the specialist. The result is that science, as such, has outstripped the layman by centuries. It has left him a helpless and bewildered figure in the center of a scientific age!

It is the duty of educators today to accept the importance of science. We should foster and encourage those efforts which have been made to place science in the elementary school program. Why should not science be treated as a fundamental subject in elementary education? Is it not equally as important as readin', writin' and 'rithmetic? As Dr. Craig once said, "In a very real sense children have the RIGHT to demand that science be a part of their education because it is so much a part of their lives." Until science in the elementary schools is given a fundamental, tool position in the curriculum the average person will become a bewildered creature in the midst of an ever changing environment.

There is no phase of elementary school science which cannot enrich experiences in the lives of children. There is no phase which does not contribute, in some way, to the development of abilities in democratic living. Naturally, the science program must be in the hands of competent and understanding instructors.

There is a demonstration of just such an instance, at present, in one school of a large city system. The school is a small one of five teachers. It is located on the fringe of the city, in the heart of a new district which has been settled, largely, by the peasant type of foreigner. December seventh brought trouble, temporarily, to this district but the wisdom of the head teacher of the school and a private session with young Japan finally restored unity. Shortly thereafter, instructions for victory gardens were issued. The head teacher grasped the opportunity which this offered. The surplus yard space was set aside and the entire school plunged heart and soul into "ventures with vegetables for vitamines for victory."

Soil condition was the first problem to confront the children. The soil of this district is difficult to work and lacks many qualities for richness. When this problem was solved the children had met with varied experiences. They had been guided in meaningful interpretations of these experiences. The result is that they understand many of the important concepts of science which are related to soil formation, fertilization, drainage, animal life in the soil, and so on.

The second problem was what seeds and plants to use which would mature before school closes in June. Through guidance, choices were made and the work proceeded. Experiences with varieties of seeds and plants followed. The result will be, as the garden develops, the understanding of science concepts which are related to the ways in which new plants are produced, how plants grow, weed problems, moisture and cultivation, function of the flower, nutrition, and so on.

In addition to the science implications involved, the garden activity has made striking contributions to a democratic way of life. For example, young Japan, so recently obnoxious, was chosen as leader of one of the garden groups and is acting adviser to all the groups because he knows so much about gardening! The families of the community are interested and have shown it by donating quantities of old fashioned fertilizer! The problem boy of the school voluntarily chose to help the kindergarten. He has taken full charge of their small garden. The larger boys offered to prepare and fence the plot for the primary children before they joined their own groups. What greater evidence could there be that all are working for the common good?

The competent teachers in this school have recognized the fact that science can be a fundamental tool. The children are learning to think scientifically. The scientific method is the "right way to work." The happy spirit of the school has spread to the homes and has developed a group interest. If the children of this community receive the same guidance throughout the remainder of their school lives, few of them will become bewildered figures in an ever changing environment!

Esther L. Guthrie
Supervisor of Science,
Sacramento City Schools,
California.

OUR OPPORTUNITY

The present struggle, which is demanding the utmost of America's capacity to produce and to make momentous decisions, is showing up certain long-standing deficiencies in our public schools. Spokesmen in industry and the armed forces tell us that many of the nation's young

men are not able to fit into their places because of their inability to read, spell, and do arithmetic and because of their lack of knowledge about their surroundings and the materials that are used in everyday living. Therefore school is being held in most of the army training camps and far more time than should be needed is being used in training more workers for industry. There is nothing inherently wrong with these young people; it is just that they were deprived of a deservedly adequate education when they went through the public schools.

The curriculum in our public schools has been revised continuously during the past fifteen years, but its basic character has changed little. During this time science has made tremendous strides and the discoveries have found their way into every branch of industry and personal life. It is now almost impossible to work and enjoy life in this country without associating closely with science and the products of science. Yet science in most of our school systems still has a relatively unimportant place in the curriculum. The average child gets little instruction in science—in the things that comprise his environment—until he reaches the last year of the junior high school and then a foreign language, public speaking, music, or art may crowd science out of his program. Only a small percentage of students take any high school science other than biology.

Small wonder is it then that the gap between science (and industry) and the average citizen has become so great that the nation has WPA and relief rolls at a time when more workers are needed desperately.

I believe that this situation is now due to be remedied. Schools are going to have to teach pupils the skills needed in everyday living and the information about this natural and man-made world that a person must have to compete successfully for a living in our industrial civilization. This means that science instruction, especially in the elementary and junior high schools, has a good chance of getting the consideration it deserves. A comparatively small group of foresighted educators have for years been pointing out the essential contribution of elementary science to the program of instruction in the elementary school, and it now appears that their advice is to be heeded, somewhat belatedly but not irreparably so.

Of course, this calls for some joy, but far more work than joy is needed among the promoters of elementary science. Many problems still need to be solved and essential truths to be determined if elementary science is to justify its inclusion in the basic elementary curriculum. For instance, more information is needed on the specific outcomes that can be achieved in each grade level by science instruction. Fortunately a sub-committee report on this subject, prepared under the direction of W. C. Croxton of the National Committee on Science Teaching, has been issued. But it will not be the last word; more work is needed.

More work is also needed on the in-service training of teachers for elementary science. The thousands of elementary teachers now in our schools know little about elementary science or how to teach it effectively, and they must be trained in an easy, inexpensive manner.

More information is needed on effective procedures for guiding pupils to form desirable habits and attitudes as they attend school. Much of this is in the field of elementary science since many of the habits and attitudes have to do with the pupil's reactions to his environment and to his own body. The status of health education in our schools is deplorable, and elementary science can do much to improve it.

These and other pressing problems cannot be solved by college professors and administrators alone—much must come from the classroom teachers of America. We must encourage good teachers everywhere to report their successful techniques so that they can be used by others. A sub-committee of the National Committee on Science Teaching, headed by Mr. Emil Massey of the Detroit Public Schools, is now collecting such data for publication. The sub-committee deserves your assistance.

These times call for hard work and realistic thinking on these and other problems in elementary science. With such work we not only promote elementary science, but we aid materially in making America's mass education endeavor a success. Remember that the future of the nation depends not entirely on our armed forces; it depends also on the extent to which we can prepare the next generation to take over and live successfully in the world that we are going to leave it.

JACK HUDSPETH
*Austin, Texas, Public Schools,
President, Department of Science Instruction of the N.E.A.*

DEFENSE TRAINING IN THE SCIENCE CLASSROOM

Given opportunity to satisfy interest aroused in the world about them, children gain much understanding, develop desirable attitudes and acquire some of the habits of scientific thinking as indicated by the following anecdotes:

The activities of Mr. Thomas aroused the curiosity of third grade children who from playground and classroom watched him "dig up his lawn" and "throw many stones in a pile." A wise teacher, recognizing the absorbing interest, arranged an observation period when children assembled their questions and stated their guesses or hypotheses as to what Mr. Thomas' real plans were.

Interest did not abate at all while the stones were carefully fitted and pounded into a wall across the front of the old lawn which was first raked smooth and gently sloping.

In class conversations curiosity was satisfied, and all of their questions were answered. "Mr.

Thomas was making a new lawn." "He made a stone wall to keep the dirt from washing away." It was spring and "Spring rains carry dirt onto sidewalks and into streets." "This is called erosion." The children had seen this happen. "Rain just spoils lawns without grass." "Sometimes erosion makes gullies." And "Gullies spoil lawns because they are long deep holes."

Monday morning brought new interests and more curiosity. There was a pile of black dirt on each side of the walk to Mr. Thomas' house.

The children watched him "spread the black dirt all over the top of his yard in a thick layer," they watched him "sprinkle fertilizer from a big bag all over and rake it into the dirt." They learned all about the fertilizer. They watched him sprinkle the lawn several times each day "to keep it moist." On Thursday they saw him sow his grass seed. Many were the questions raised as he covered the whole lawn with "gunny sacks" and "large cardboards" before he sprinkled it again "with the hose."

There were many hypotheses suggested as reasons for the covering, but Mr. Thomas himself approved of the following three:

To keep birds (sparrows) from eating the seeds

To help keep the ground warm at night

To keep the seeds from blowing or washing away.

After eight days of faithful watering Mr. Thomas carefully uncovered the lawn. It looked "black" from the schoolroom windows, but "perhaps he could see something that we could not" was the suggestion of one child.

Was not this remark indicative of suspended judgment?

The class, on an inspection tour, discovered emerging from the new lawn both tiny clover leaves and green shoots of grass. They concluded from this that Mr. Thomas was right in removing the cover. "He wouldn't want the cover to make it (the lawn) yellow." "The sun makes grass green."

Two days later the children viewed from their windows a green lawn which they said "would make a thick green carpet over the whole yard." Now Mr. Thomas was putting "a string fence all around his yard" which children interpreted as saying to them: "Please be careful and let me grow."

Now children thought they knew how to make a lawn. They would tell their fathers how and help them fix their own lawns.

Behavior on succeeding field trips in the neighborhood indicated that the children had gained more respect for lawns in the community.

A fourth grade group of children studying Switzerland were experimenting to learn more about erosion by pouring water down the side of a hill in their sand table. They saw the water wash a gully and drop sand on the flat below forming a delta. They summarized their learnings in this way:

"Water can cut through rocks.

"Some streams cut deep valleys.

"Water is very strong when it flows swiftly and carries soil.

"Water steals sand and pebbles from one place and carries them to other places.

"Water is always leveling the land."

Some child called the delta, "the Netherlands." The teacher guide transferred interest to a physical map of Europe and asked the children if John had been correct in saying that the Netherlands was the delta of the Nile. The children eagerly studied the map and verified there the learnings they had gained from experimentation at the sand table.

These are illustrations of children's way of learning when and if they are carefully and thoughtfully guided by a skilled teacher. It is the scientific way of learning charged with the real spirit of search for truth.

If and when the skilled teacher helps children to see opportunities for application of their learnings to new situations the children will grow in the development of habits of reflective thinking and in scientific attitudes.

The classrooms of the elementary school offer numerous opportunities for this type of teacher guidance in thinking because children once awakened to the world of nature and scientific development about them constantly present questions and problems of great variety relative to life and living.

The teacher must be able to help the children simplify their problems by reducing their sometimes very complex statements to two or more elemental questions.

Children at all elementary levels are able to draw conclusions from data which they themselves gather as a result of observation, simple experimentation, reading and in other ways.

In gathering data and in conversational discussion relative to their self-initiated problems children, guided by a democratic teacher, learn to be tolerant of the opinion of others and to weigh evidence very meticulously. The classroom that undertakes such learning situations must be very democratic. The children must learn to be cooperative. The teacher must discover the abilities of Mary, Jane, Jim and John and must guide experiences in such a way that each individual has a share comparable with his ability.

From such classrooms the following incidents were taken:

A group of sixth grade boys, playing ball on school playgrounds on a Saturday morning were attracted by the peculiar behavior of a killdeer. In accordance with habit they investigated and found a nest full of eggs. The ball diamond was moved to a more distant part of the school grounds. The nest was guarded by a barricade of stones and scraps and a note advising "other fellows to let the birds have a chance to raise their babies" was weighted down in plain sight in the barricade.

Monday morning found a committee of these boys in the principal's office arranging for continued protection. The nestlings demonstrated the progress of killdeer infancy for an interested school citizenry and provided background for comparison with development of not only robin babies but other forms of animal life.

A group of boys on a ramble through an extended ravine and meadow park discovered a chipmunk suffering in a cruel trap. They released the chipmunk. They spotted several other traps as they tramped, and they heartily discussed the harm done by such gadgets. They took their story on Monday to their teacher. They posted themselves and their classmates upon traps and trapping and upon laws made to protect wildlife. They decided this infringement of law in a city park should be reported to proper authorities. A letter was written to the Park Board giving facts. A map indicating location of the infringements was sent with the letter to the Park Board. These boys received from the Park Board Superintendent a letter of acknowledgment and appreciation of their service.

A teacher reports that a newspaper clipping headed "Manganese Plant at Crosby, Minnesota, Plans Are Rushed" led to a look into the subject of manganese.

Robert reports:

"When I was looking up manganese I found out I had made a mistake and was looking up magnesium instead. By this time I was so interested and so was the whole room and even the principal that I took magnesium as an extra topic. I got some information out of the December issue of *Popular Science*, and I got some information out of the *Minneapolis Tribune*. That information was that 4,500,000 tons of magnesium can be taken from one cubic mile of seawater. (One cubic mile means a mile across, a mile wide and a mile deep)."

Needless to say that Robert's reports upon the discovery, sources and uses of these valuable defense minerals opened an interesting and almost new field of activity to the girls and boys of his classroom.

Today in the classrooms of the country there are many teachers who are guiding children in practices of reflective thinking which should lead to behavior based upon knowledge and wise judgment; which should also lead to abilty to gain knowledge and to solve problems when need arises.

Is this not one of the best forms of defense training?

JENNIE HALL
Adviser in Science,
Minneapolis Public Schools.

Editor's Note.—This special issue was originally planned as the April, 1942, number. Due to circumstances, as explained in the October–November issue, page 157, it was necessary to postpone its publication until this time, with the permission of the National Council on Elementary Science.

The articles and editorials of this issue were provided by Miss Rose Lammel, acting as a committee of one for the N.C.E.S. Miss Lammel undertook the assignment at a very late date but collected what we believe to be an outstanding set of materials in time for the April issue. We regret the late publication of the materials but are delighted with its quality.

Abstracts

PALMER, E. LAURENCE, THURBER, WALTER, AND SCHMIDT, VICTOR H. "Teachers Number." *Cornell Rural School Leaflet* 35: 3–63; September, 1941.

This Leaflet lists, by date and subject, the Leaflet radio program for 1941–42, summary of all Leaflets and their contents published from 1920 to 1941, and index covering the period 1931 to 1941, an article on "Habit Formation" by Paul J. Kruse, and a series of units on "Elementary-School Natural History Indoors." Each unit includes a brief overview, equipment, what to do, and follows up. Units are as follows: (1) "How some animals behave," (2) "How some animals respond to light," (3) "How some animals respond to light and heat," (4) "How a land snail obtains a meal," (5) "The cooling effect of a breeze," (6) "Soda pop," (7) "Dry ice," (8) "A study of some common acids," (9) "Quick-rising breads," (10) "Is some water hard?" (11) "How to print pictures," (12) "The effect of noise on one's ability to work," (13) "Some apparently simple things we are unable to do," (14) "Electric lights in the play-house," (15) "The magnifying glass," (16) "The response of some animals to gravity," (17) "Effect of light on inanimate substances," (18) "Color changes," (19) "Can insects detect odor?" and (20) "Do bees use color to help them find food?"

—C.M.P.

PALMER, E. LAURENCE. "Outdoor Living." *Cornell Rural School Leaflet* 34: 3–32; March, 1941.

This Leaflet should appeal to all persons who enjoy outdoor life. A wealth of illustrations add much to its enjoyableness and practicality. The Leaflet helps you to plan something to eat, and tells how to cook some foods. It shows you how to roll and carry packs; how to keep warm and dry; what to do when you are thirsty; what plants and animals are dangerous; how to have fun; and how to avoid getting lost.

—C.M.P.

PALMER, E. LAURENCE. "Holes in the Ground." *Cornell Rural School Leaflet* 35: 3–31; November, 1941.

This article discusses the following aspects of holes in the ground: (1) "Our soil," (2) "A view through the soil," (3) "A woodchuck explores the soil," (4) "The soil in a forest," (5) "Some smaller holes," (6) "Some valuable diggers," (7) "Plants explore the soil," (8) "Shallow-rooted plants," (9) "Deep-rooted plants," (10) "Air in soil," (11) "Water and the soil," and (12) "Erosion."

—C.M.P.

PALMER, E. LAURENCE. "More about Water." *Cornell Rural School Leaflet* 35: 3–31; January, 1942.

The following relationships of water are discussed: (1) "Temperature," (2) "Hard water or soft water," (3) "Fun," (4) "Sports," (5) "Safety," (6) "Accidents," (7) "Ice," (8) "Beauty," (9) "Fiction, fable, and superstition," (10) "Life," (11) "Health," (12) "Transport," (13) "War," (14) "Fire," (15) "Power," and (16) "Moving water."

—C.M.P.

HILDRETH, RUTH C. "A Visit to the Laundry." *The Instructor* 50: 57; March, 1941.

This is one of a series of units on "Let's Find the Facts for Ourselves." It is intended for the fifth grade and includes three major divisions: preparation, the trip, and results.

—C.M.P.

STEVENS, MARION PAINE. "Life in the Old Stone Age." *The Instructor* 50: 39–48; March, 1941.

This illustrated science unit presents overview, objectives, possible approaches, general concepts, activities, and bibliography.

The primary grade unit is entitled "The Story of a Cave Boy," the middle grades unit, "Shelter, Food, and Animals," and the upper grades unit, "Arts and Crafts."

—C.M.P.

PAINTER, FLORENCE M. "The Conservation Unit." *The Grade Teacher* 58: 42–43; 88–89; April, 1941.

This unit for the intermediate and grammar grades emphasizes soil conservation.

—C.M.P.

WAGNER, EMMA. "Seeds." *The Grade Teacher* 58: 26; 81–82; April, 1941.

This unit in elementary science is intended for the primary grades.

—C.M.P.

BOULTER, MARJORIE. "A Study of Ants." *The Instructor* 50: 16, 63; April, 1941.

This middle grades science unit lists: important problems, how the unit progressed, activities, outline of subject matter, and bibliography.

—C.M.P.

MEERS, MARY, AND DEANE, AMY. "Trees—Their Beauty and Uses." *The Instructor* 50: 22; 63; April, 1941.

This middle grade science unit includes: aims, specific objectives, subject matter, correlated subjects, and outcomes.

—C.M.P.

McDIVITT, HELEN. "Thousands of Baby Chicks." *The Instructor* 50: 58; April, 1941.

This *Let's Find the Facts for Ourselves* unit discusses: preparation for the trip, questions raised, information gained from the trip, correlations, and outcomes of our trip.

—C.M.P.

BLOUGH, GLENN O. "How Is Electricity Important to Us?" *The Instructor* 50: 39–48; April, 1941.

This illustrated unit lists objectives, problems and important meanings to be developed (for each grade level), pupil bibliographies for each grade level, teacher bibliography, and activities for each grade level. The primary grade unit is entitled "How Do We Use Electricity?" the middle grade unit "How Are Electrical Circuits Important?" and the upper grades unit "What Does Electricity Do in Our Homes?"

—C.M.P.

BRANLEY, FRANKLYN M., AND LEE, HERBERT. "The Solar System." *The Grade Teacher* 58: 49; 82; April, 1941.

This elementary science for the grammar grades includes important facts, activities, and test.

—C.M.P.

EAGLES, GRACE KING. "We Visited a Bleach, Dye, and Print Works." *The Instructor* 50: 54; May, 1941.

This *Let's Find the Facts for Ourselves* unit includes: approach, teacher's objectives, preparing for the trip, the trip through the mill, correlations and conclusions obtained, and questions to summarize activity.

—C.M.P.

DE PENCIER, IDA BREVAD. "The Cotton Industry." *The Instructor* 50: 39-48; May, 1941.

This illustrated unit of work presents overview, objectives, possible approaches, procedure, pupil bibliography, and activities for each unit. The primary grades unit is entitled, "Growing Cotton and Manufacturing Cloth"; the middle grades unit, "Sources and Uses of Cotton"; and the upper grades unit, "Problems of Growers and Manufacturers."

—C.M.P.

BRINK, IDA K. "How to Make a Terrarium." *The Grade Teacher* 58: 46; 61; May, 1941.

This project in elementary science discusses the building and planting of a terrarium.

—C.M.P.

LAURENE, SISTER M. "Our Feathered Friends." *The Grade Teacher* 58: 16–17; 68; May, 1941.

This illustrated elementary science unit presents: preparation, questions, correlation of subjects, bird songs and calls, nesting time and nest building, location of nest, the egg, baby birds, and bird program.

—C.M.P.

STEVENS, MARION PAINE. "Grains, and How We Use Them." *The Instructor* 50: 39–48; June, 1941.

This illustrated unit includes a general overview, general concepts to be developed, method of teaching activities for the unit, pupil bibliographies for three grade levels, and a teacher bibliography. The primary grade unit is entitled "The Story of Bread," the middle grade unit "Corn and Its Products," and the upper grades unit "Other Grains of the World."

—C.M.P.

WHITNEY, RONALD L. "The Oil Unit." *The Grade Teacher* 59: 58–59, 89; September, 1941.

This grammar grade unit briefly outlines the process of oil refining and indicates class activities that may be carried out in studying this unit.

—C.M.P.

LINDERMAN, HAZIEL. "The Second Grade Plant Store." *The Instructor* 50: 18; 68; September, 1941.

This is a second grade unit in elementary science that involves a maximum of group and individual activity and cooperation.

—C.M.P.

ROWE, REATHA L. "Autumn Sign Boards." *The Grade Teacher* 59: 50–51; 94–95; September, 1941.

This elementary science unit intended for the intermediate grades presents the following aspects of autumn changes: relation of sun and earth, and how plant life, animal life, and human beings prepare for winter.

—C.M.P.

PETTINGILL, OLIN SEWALL. "Bird Walks the Year Around." *Biology Briefs* 4: 18–20; October, 1941.

Bird walks to be successful in achieving their purpose must be conducted with a plan and with enthusiasm. Equipment should consist of a binocular, a pocket handbook of birds, a field check list, and a pocket notebook. The article discusses specifically where and when to go and uses of information gained.

—C.M.P.

WHITNEY, RONALD L. "A Miniature Iron Smelter." *The Grade Teacher* 59: 52; 70–71; October, 1941.

This article intended for the grammar grades describes the process of refining iron and suggests how a miniature smelter may be constructed in the classroom.

—C.M.P.

RAPPEPORT, LORRAINE K. "Elementary Science Lessons with Simple Experiments." *The Grade Teacher* 59: 28, 75; October, 1941.

This unit for the primary grades describes various science activities such as: class walks,

making nature collections, changes in the fall, making footprints, and a classroom beehive.
—C.M.P.

ISMERT, ETHEL. "We Learn About Fishes." *The Instructor* 50: 28; 66–67; October, 1941.

This science unit intended for all the grades includes objectives, teacher's planning and preparation, possible avenues of approach, approach used, development, and bibliography.
—C.M.P.

BETTS, MARIAN PARKER. "Little Frog." *The Instructor* 50: 41; 76; October, 1941.

This dramatization, intended for the primary grades is based on the story "Little Frog" from *Round About.* There are three scenes and suggestions for costumes and setting are included.
—C.M.P.

WHITNEY, RONALD L. "Why Not Have a Science Fair?" *The Grade Teacher* 59: 62–63; October, 1941.

This article presents some useful suggestions for science fairs both as to methods of initiating and as to types of exhibits.
—C.M.P.

BLOUGH, GLENN O. "How Science Helps Industry in the United States." *The Instructor* 50: 45–54; October, 1941.

Each grade level has a test of problems for supplementary lessons, important meanings to be developed, pupil activities, things to do, pupil bibliography, and teacher bibliography. The primary grades unit is entitled "Where Do the Things We Need Come From?" The middle grades unit is entitled "Science Helps Food and Clothing Industries," and the upper grades unit is entitled "Scientific Discoveries and Inventions."
—C.M.P.

ANONYMOUS. "Nevada Winter." *U. S. Camera* 4: 47–50; December, 1941.

There are four excellent pictures with descriptive material as to conditions of taking, camera used, and techniques involved.
—C.M.P.

GRAINGER, HAROLD G. "Pictorialism for Beginners." *Camera Craft* 48: 637–679; November, 1941.

This article points out the need for centralizing the chief interest in every picture made. Examples of good and bad centralization are included.
—C.M.P.

BLUM, JOHN L. "The Identification of Bible Plants." *The Science Counselor* 7: 104–106, 128; December, 1941.

This article identifies several of plants mentioned in the Bible, pointing out that plants mentioned by familiar names may not be those which we know by the same name.
—C.M.P.

STERLING, LAWRENCE. "Your Eyes and How They Function." *The Educational Focus* 12: 10–17; Winter 1941–42.

This excellent article is accompanied by six unusually fine photographs graphically showing the common defects of the eye.
—C.M.P.

HOLLENBECK, BEATRICE S. "How One Teacher Made a Bird Sanctuary in Her Schoolyard." *The Instructor* 51: 11; January, 1942.

Six pictures illustrate this article on a project carried out in a rural school.
—C.M.P.

MILLER, ELIZABETH CHRISTINE. "When We Went to the Museum." *The Instructor* 51: 17; 74; February, 1942.

This is the description of a trip made to a science museum by a group of primary children. Preparation for the trip, purpose of the trip, possible integration, possible outcomes, and additional reminders are given in an excursion. A program based on this trip was presented before the mothers of the children.
—C.M.P.

WHITNEY, RONALD L. "Our Weather Bureau." *The Grade Teacher* 59: 49, 56; January, 1942.

This is an activity unit intended for the grammar grades.
—C.M.P.

THOMAS, KATHARINE. "Weather and Climate." *The Grade Teacher* 59: 50–51; 56–57; January, 1942.

This article supplements the preceding one and lists aims, development of content, activities, and bibliography.
—C.M.P.

DOWNING, EDITH. "We Learn About Weather and Climate." *The Instructor* 51: 8–9; 57; January, 1942.

This is an elementary science unit intended for the primary grades. Correlation with reading, art, and arithmetic is stressed.
—C.M.P.

BLOUGH, GLENN O. "How Science Helps Commerce in the United States." *The Instructor* 52: 37–46; January, 1942.

This illustrated elementary science unit presents an overview of the unit, objectives and teacher bibliography for the whole unit together with pupil bibliography problems for supplementary lessons, important meanings to be developed, things to do, and activities for each of three grade levels. The primary grade unit is entitled "Why Do We Need Ways to Carry Things?" the middle grades unit, "How Have Inventions Helped Us to Carry Goods?" and the upper grades unit "Scientific Problems of Commerce."
—C.M.P.

ANONYMOUS. "Camera Records Cataract Removal." *U. S. Camera* 5:40–41; January, 1942.

This is a series of eight interesting pictures with descriptive material.

—C.M.P.

ANONYMOUS. "Lincoln Photos Indoor Wild Life." *U. S. Camera* 5:28–30, 71; January, 1942.

This is a series of interesting pictures made in the American Museum of Natural History by F. S. Lincoln. Descriptive material accompanies the article.

—C.M.P.

BRANLEY, FRANKLYN M., AND LEE, HERBERT. "Sound." *The Grade Teacher* 59:51; 68–69; February, 1942.

This unit on sound is intended for the upper intermediate and grammar grades. Fourteen activities and a bibliography are included.

—C.M.P.

RYSER, MARCELLA. "A Unit on Aircraft." *The Instructor* 51:22; 76; February, 1942.

This primary grade unit includes possible approaches, subject-matter, consumers' enterprises, producers' enterprises, problem-solving enterprises, specific learning enterprises, outgrowth into other units, and bibliography.

—C.M.P.

KELLEHER, AGNES MARY. "A Model Dairy Farm." *The Instructor* 51:23; 64; March, 1942.

This is a brief outline of a unit intended for all of the grades.

—C.M.P.

BRANLEY, FRANKLYN M., AND LEE, HERBERT. "Light." *The Grade Teacher* 59:48; 62; March, 1942.

This elementary science unit on light is intended for the upper intermediate and grammar grades. Ten possible activities are presented along with a bibliography, objective test, and sources of free and inexpensive material.

—C.M.P.

UPCHURCH, FREDRICA. "Peanuts." *The Instructor* 51:18–19; 69; March, 1942.

This excellently worked out unit includes objectives, procedure, development of the unit, supplementary activities, and bibliography.

—C.M.P.

DUNCAN, VIRGINIA. "An Opossum Family Goes to School." *The Instructor* 51:13; March, 1942.

This is a picturized article telling how a second grade teacher brought a mother opossum and her nine children to school. They were kept in the schoolroom for three weeks.

—C.M.P.

BOUSA, LAURETTA M. "Agriculture." *The Grade Teacher* 59:46–47; 53; April, 1942.

This elementary science unit lists objectives, procedure, experiments, and possible correlations with other subjects. —C.M.P.

COPPS, MARY NEELY. "Footwear." *The Grade Teacher* 59:38; 55; 77; April, 1942.

This unit for the elementary grades presents a history of shoes, raw materials used in making and pupil activities.

—C.M.P.

CURRENS, JEAN. "A Schoolroom Terrarium." *The Grade Teacher* 59:33; 75; April, 1942.

This descriptive article describes the construction of a terrarium and lists some of the activities that children may carry on relating to it.

—C.M.P.

MARTIN, MARY R. "The Bakery." *The Instructor* 51:15; 59; March, 1942.

This primary grade unit includes objectives, approaches, development of the unit, lists of questions, activities, and evaluation.

—N.M.B.

Book Reviews

SCIENCE EDUCATION BOOKS

UNDERHILL, ORRA E. *The Origins and Development of Elementary-School Science.* Chicago: Scott, Foresman and Company, 1941. 347 p. $2.50.

This volume reviews the activities of educators who, through a century and a half, have been working to provide for children in the elementary schools experiences with content and methods of science appropriate to their maturity levels. The study had three major aims: (1) "To set forth the backgrounds of the development of science programs from their first appearance as a part of the general education of children in the elementary schools of the United States to the present." (2) "To determine for what purpose science has been introduced into elementary-school programs and the way in which these purposes have affected methods of selecting, organizing, and presenting it," and (3) "To determine how educational theory has influenced the selection, organization, and presentation of science materials as a part of an elementary-school program. Each of the six sections of the study, which represent chronological periods, has been organized into three sections each corresponding to these three aims. The first period covers 1750–1850; the second, 1825–1860; the "object-teaching" period, 1860–1880; the fourth period, 1890–1920; the "Nature-Study" period, 1890–1920; and the sixth period, "recent trends"—1910 on.

Altogether this is an excellent research study and throughout there is evidence of careful inquiry, documented on nearly every page with selected statements elucidating the general statements that have been made. Historically and educationally, this research is a real contribution to the field of science education in general and to elementary science in particular. The reviewer enjoyed it very much as did the members of his elementary science methods course. We need a similar all-inclusive study in secondary science. Only biology and chemistry have had similar treatises and these are considerably more brief, and lack the "atmosphere-making" one feels from the "spicy" reading found in this treatise.

—C.M.P.

RIDDLE, OSCAR, FITZPATRICK, F. L., GLASS, H. B., GRUENBERG, B. C., MILLER, D. F., AND SINNOTT, E. W. *The Teaching of Biology in Secondary Schools of the United States.* Cold Spring Harbor, New York: Oscar Riddle. 1942. 76 p.

This is the report of results from a questionnaire sponsored and published by The Committee on the Teaching of Biology of the Union of American Biological Societies. Different segments of this report have been published in *The American Biology Teacher,* abstracts of which have been printed in SCIENCE EDUCATION. The report is based on replies from 3,186 biology teachers, widely distributed over the United States. No general conclusions are given except those found at the end of the several reports. Section reports are as follows: (1) "General Information on the Experience and the Subjects Taught by Biology Teachers" by D. F. Miller; (2) "Enrollments, Teaching Load and College Relations of Secondary School Biology" by H. B. Glass; (3) "The Training of Biology Teachers" by Frederick L. Fitzpatrick; (4) "Buildings, Equipment and Textbooks used by Teachers of Biology in Secondary Schools" by Edmund W. Sinnott; (5) "Community Backgrounds and School Organizations" by Benjamin C. Gruenberg; and (6) "Amount and Nature of Biology Teaching in Secondary Schools" by Oscar Riddle.

—C.M.P.

WOODRING, MAXIE NAVE, OAKES, MERVIN E., AND BROWN, H. EMMETT. *Enriched Teaching of Science in the High School.* New York: Bureau of Publications, Teachers College, 1941. 402 p. $3.25.

This is the second edition, revised and enlarged, of a publication that had great demand when first published in 1928. In later years many science teachers have looked forward hopefully to this revision. One of the greatest handicaps of such a publication as this is that some of the material listed is soon unavailable, almost before the book is brought from the press. Practically all of the book has been rewritten and the major topics rearranged. Part one lists free and inexpensive materials that may be obtained for the teaching and illustration of science content. Under this are such headings as "space and time," "the changing earth," "growth and development," and "science as a way of thinking." Part two is devoted to materials, methods, and activities. This includes: (1) "Audio-Visual Materials and Techniques," (2) "Scientific Equipment and Supplies," (3) "Clubs; Excursions; Hobbies," (4) "Careers in Science," (5) "Summer Activities," (6) "Professional Associations," (7) "Tests and Science Vocabularies," (8) "Periodicals of Interest to Science Teachers," and (9) "A Science Teacher's Library." Source addresses, and an index complete the volume. With such publications as this available at so reasonable a price there is small excuse for any science teacher not having a great variety of free and inexpensive material that add both to classroom teaching efficiency and to having a science classroom possessing a "science appearance and atmosphere."

—C.M.P.

SCIENCE TEXTBOOKS AND MANUALS

CRAIG, GERALD S., BURKE, AGNES, AND BABCOCK, MARY FLOYD. *We Want to Know.* Boston: Ginn and Company, 1941. 126 p. $0.68.

This is the seventh and last book of a series of elementary science readers entitled "New Pathways in Science." The authors not only believe but here demonstrate that the child can be introduced to science as early as he can be introduced to any school experience. Six units are organized about boys' and girls' everyday experiences. Especial attention has been paid to the vocabulary, both as to comprehension and desirable repetition. Appealing, meaningful pictures are used profusely, many in colors. What a delightful, challenging introduction to a child's first school experience in science is afforded by this elementary science primer.

—C.M.P.

CARPENTER, HARRY A., BAILEY, GUY A., AND TUTTLE, M. ELIZABETH. *Adventures in Science with Doris and Billy.* Boston: Allyn and Bacon, 1941. 249 p. $0.88.

This is the fourth book in the Rainbow Readers in elementary science. It is like its predecessors in format, in use of color, in its seasonal development of content, in having two children as its leading characters, in its especial attention to vocabulary, in its careful attention to scientific terms, and in its merry inkies. The latter are beginning to grow up even to creeping into the textual material itself. They illustrate scientific principles with a touch of humor.

The book is appealing and artistic both outside and inside. Decorative sketches appear on the introductory pages of each unit. Each unit is introduced with an attention-getting colored picture. The glossary has a special feature. Each word is illustrated by a simple marginal drawing. The thirteen units of subject have been carefully selected with the proper balance between biological and physical science aspects.

This book is added proof and a concrete example, that elementary science can be made appealing, challenging, scientifically accurate, without the least necessity of "writing it down."

—C.M.P.

BLOUGH, GLENN O. *An Elementary Science Group at Work.* Chicago: Scott, Foresman, and Company, 1941. 31 p.

This is the stenographic reports of a series of five lessons in an elementary science unit on electricity. The author is instructor in elementary science in the Laboratory Schools of the University of Chicago.

The material is based on the *Discovering Our World* science series for the middle grades. Such reports as these by experts in the field, should serve a most useful purpose, both for active and for prospective teachers. We are greatly in need of more verbatim reports indicating how elementary science may be more effectively taught.

—C.M.P.

CRAIG, EDNA, AND STONE, GEORGE K. *Experiences in Life Science.* New York: The MacMillan Company, 1942. 186 p. $0.88.

This seems to be much better than the average workbook in the field of biology. It is well and simply organized. References to fifteen biology textbooks are given for use with this workbook. The sheets are perforated so that they may be detached for filing. Drawings are used throughout to aid the student in his understanding of the subject matter. Four rather comprehensive tests are found in the last few pages.

—Roy V. Maneval.

ANONYMOUS. *Practical Problems in Physical Science.* Los Angeles: Office of the County Superintendent of Schools, Division of Secondary Education, 1940. 80 p.

This is a mimeograph bulletin made available through the Works Project Administration. It is not intended as a body of subject matter nor as a collection of scientific facts. The bulletin lists seventeen science units that may be used in secondary schools. Emphasis is upon the practical aspects of science. The units are as follows: (1) "Using the Automobile," (2) "Building," (3) "Using Electricity," (4) "Using the Radio," (5) "Heating and Air-Conditioning," (6) "Refrigeration," (7) "Lighting," (8) "Photographing," (9) "Using Tools and Machinery," (10) "Preserving and Removing Corrosion," (13) "Using Textiles and Clothing," (14) "Using Water," (15) "Preventing and Fighting Fire," (16) "Conserving Soil and Natural Resources," (17) "Living Out of Doors."

Each unit lists several major problems, with numerous questions under each major problem. Following this a list of activities and community resources for that particular unit, and a list of selected references for that unit.

All secondary science teachers and others desiring to make their physical science courses more practical, will find this bulletin an excellent source of supplementary problems and questions.

—C.M.P.

HUNTER, GEORGE W. *Life Science.* New York: American Book Company, 1941. 803 p. $2.08.

Life Science emphasizes the social and economic aspects of high school biology. The approach is made through a study of worth-while problems so that the student will integrate the experiences gained in studying the various units into his own life and thinking. The psychological rather than the logical viewpoint has been utilized in presenting the subject matter. Science as a way of thinking has been emphasized and numerous exercises have been included to give practice in this aspect of learning. Believing that motivation is very important, the author has included many de-

vices for motivation of the pupil toward desirable attitudes and habits. In order to provide for individual difference, not only has material of several grades of difficulty been provided, but also there has been included a large number of end exercises in the form of demonstration, student activities, project, report, and self-testing materials. An attempt has been made to reduce technical vocabulary to a desirable minimum. The content is divided into four major aspects: "Biology for Work and Play," "Personal Biology," "Biology in Our Lives," and "Biology and Social Life." Each of the twelve units has a preview, a series of problems to be solved, word-mastery list, self-tests, and reading references.

Altogether the general appearance of this book is most pleasing. The photographs and illustrations are excellent, the content timely, interesting and challenging, and the literary style most readable.

In the opinion of the reviewer this is one of the very best high school biology texts now available. *Life Science* is deserving of most wide usage. Evident throughout is the author's many years of leadership in the field of high school biology and his up-to-dateness in educational research. Professor Hunter has long been an outstanding leader in secondary science education in America. —C.M.P.

HUNTER, GEORGE W., AND KITCH, LORAN W. *Activities in Life Science.* New York: American Book Company, 1942. 362 p. $0.88.

This workbook is written especially to accompany *Life Science* by Hunter. Each of the twelve units consists of a number of problems. The activities for each unit are divided into "Organization Materials" and "Assimilative Materials." Space is provided for the student's answers to various types of tests which are given in the text. These tests include those on scientific attitudes, word mastery, ability to do reflective thinking, and fundamental concepts.

—Roy V. Maneval.

POWERS, SAMUEL RALPH, NEUNER, ELSIE FLINT, BRUNER, HERBERT BASCOM, AND BRADLEY, JOHN HODGDON. *Our World and Science.* Boston: Ginn and Company, 1941. 654 p. $1.76.

Our World and Science is a single-volume general science text intended for the ninth grade. There is also a three-volume series "Adventuring in Science" by the same author intended for the seventh, eighth, and ninth grades.

Judged from almost any viewpoint, *Our World and Science* is a superior textbook in its field. Artistically, pictorially, psychologically, the book should be challenging, interesting reading to ninth-grade youngsters. The pictures and diagrams are excellent, being pertinent, interesting, and serving as valuable teaching adjuncts to the subject-matter. Many are full-page photographs. The paper is of such quality as to reduce eye-strain and the type is most readable. The literary style is to be highly commended for its simplicity, clarity and color—aims consciously strived for by the authors. Especial attention has also been paid to vocabulary in an attempt to avoid both confusion and condescension. The content seems to have been most carefully selected.

There are eight units as follows: (1) "The World of Sky," (2) "The World of Water," (3) "The World of Air," (4) "The World of Living Things," (5) "The World of Rock," (6) "The World of Action," (7) "The Preservation of Health," and (8) "The Conservations of Wealth." Each unit has a brief preview, a series of exercises or experiments, a list of statements to be corrected, questions for discussion, and things to do. At the end of the book is a well-selected list of readings in science, and a list of science words that have been carefully defined. There is a page reference indicating where the word may be found in the textual material.

"Our World and Science" is concrete evidence that the best books in secondary science are still being written in general science and biology. No college texts approach the textbooks written in these fields.

—C.M.P.

BUSH, GEORGE L. *Science Education in Consumer Buying.* New York: Bureau of Publications, Teachers College, 1941. 228 p. $2.35.

The reviewer has long felt and still feels that schools should pay more attention to the problems of consumer education. Here and there, in rare instances, are found schools and courses seemingly treating this ever-increasingly important problem adequately. Intelligent buying and intelligent consumership grow increasingly important as the problems of rationing multiply, and even after the war is over, the problem could imaginably be even much more important than it is now.

This is the fourth of the source books in "The Science in Modern Living Series" *(Life and Environment, The Storehouse of Civilization,* and *The Control of Organisms* have been reviewed in SCIENCE EDUCATION). The first third of the book is concerned with an appraisal of several previous publications on consumer buying. This appraisal seems to be eminently fair to all concerned. Consumer items such as food, clothing, building materials, drugs, cosmetics, automobiles, and electrical appliances are considered as illustrative material. The author makes several practical suggestions for changes in the nature of consumer education. There is an excellent annotated bibliography.

While the book is addressed primarily to present and prospective teachers of science, the book should be of general interest to all laymen, and of specific interest to all teachers interested in problems of consumer education.

—C.M.P.

BANKS, CHARLES W. *Applied Science.* New York: John Wiley and Sons, Inc., 1942. 212 p. $1.75.

Applied Science includes selected, fundamental principles of physics, mechanics, hydraulics, heat, light, electricity, and the strength of materials. Mathematical processes and formulae have been kept as simple and few in number as possible. Many diagrams and problems are included. While this book would be useful primarily as a text in applied or shop science courses, physics teachers would profit by carefully noting the practical applications of physics principles that can be made.

—C.M.P.

KRAUSKOPF, KONRAD BATES. *Fundamentals of Physical Science.* New York: McGraw-Hill Book Company, Inc., 1941. 660 p. $3.50.

The materials of this book are based on a course in physical science taught at Stanford University. The course is presented in the form of two lectures and one three-hour laboratory period per week for three quarters. Content has been selected from astronomy, physics, chemistry, and geology, but each science is not treated separately; rather an attempt is made to emphasize the unity of physical science as a field of knowledge. It is intended as a course in science, not as a superficial course about science.

About one-third of text is devoted to chemistry, not quite a sixth to astronomy, and one-fourth to geology. The treatment more nearly corresponds to content of textbooks in these special fields than do a majority of physical science survey textbooks. This would be an advantage or disadvantage, depending upon your viewpoint as to best type of textbook for such a course. Thus seemingly the author's attempt to develop a course *in* science has been more or less attained. There would be many who might question his major premise as to the major function of a survey course in physical science, and as a result would not include the same general topics, and would not treat those so included in the same way. Very little attention is paid to light and color, and sound.

At the end of each chapter is a list of questions. Altogether this is a carefully planned course. Students using this as a text and attaining normal mastery of its content will surely have a well-rounded knowledge of some of the major principles and aspects of the physical sciences.

—C.M.P.

CLARK, C. C., JOHNSON, C. A., AND COCKADAY, L. M. *This Physical World.* New York: McGraw-Hill Book Company, Inc., 1941. 528 p. $3.25.

This Physical World is based on a physical science survey course taught in the School of Commerce, Accounts and Finance at New York University. The textual material is based on fifteen years of classroom experience teaching physical science survey courses. This book is a companion volume to *This Living World* previously reviewed in SCIENCE EDUCATION.

The authors state that they "have taken care to preserve throughout the text a connected account of scientific principles and their relationships. The various topics are not treated as unrelated fragments of knowledge; rather they are developed so as to show their relationship to each other."

The initial chapter includes some explanation of the nature of scientific laws and of the scientific method. Then follows material relating to astronomy, atomic structure, chemical changes, heat, wave motion and energy, sound, light, and other electro-magnetic radiations, electricity and some of its applications. Peculiarly enough this text on physical science omits any reference to geological science. This material has been included in the authors' biology survey text.

As the only completely satisfactory course outline is one made by the instructor himself, so the only completely satisfactory text is one the author writes himself, and undoubtedly he is often not completely satisfied soon after he has completed his "masterpiece." The reviewer does not agree altogether with either the topics treated or the method of treatment. This is not saying that *This Physical World* is not a good text. It is really one of the best that has yet been published. The paper is unusually high quality, the type most readable, the illustrations pertinent and well-done, the supplementary references quite well-selected, and the literary style most readable. It should prove to be a fine text for those desiring a single text, or it would do equally well as one of a series of supplementary texts.

—C.M.P.

FISHER, CLYDE, AND LOCKWOOD, MARIAN, *Astronomy;* Brentz, J. Harlen, *Earth Sciences;* Gerard, Ralph W., *The Body Functions;* and Parshley, Howard M., *Biology.* New York: John Wiley and Sons, Inc., 1940, 1941. 205, 260, 289, and 232 p. $1.75 each.

The above four titles are part of series of texts edited by Gerald Wendt for a survey course for colleges. (The chemistry and physics texts have been reviewed previously.)

The reviewer is more impressed with the material presented in the astronomy and geology texts than with the two texts relating to biology. For some reason the biology texts do not seem to be up to expectations. And this is not the reviewer's opinion alone for the same opinion has been expressed by biologists teaching survey courses in biology.

The Astronomy and Earth Sciences texts seem to be well written, altogether accurate, and the subject matter quite well selected. It is in this latter aspect, that the biology texts seem to be not quite up to par. This series of books would seem to be especially useful in those survey courses that use a series of books either as main references or as supplementary reading. The chances of one or more of this series of books

fitting into a given survey course are much greater than that a single, combined text will do so. If the latter is used, there are usually quite a few topics that do fit into the course being taught. Thus the astronomy and geology texts would fit into the reviewer's course quite well. Probably the biology texts would fit as well into biology survey courses. —C.M.P.

GENERAL EDUCATION BOOKS

DE LIMA, AGNES, and the Staff of the Little Red School House. *The Little Red School House.* New York: The Macmillan Company, 1942. 355 p. $3.00.

One of the most interesting experiments in the field of elementary education has been that at The Little Red School House in the center of New York City. There for twenty years under the leadership of the Director, Miss Elizabeth Irwin and her pioneer group of teachers, has been conducted a progressive type of school activity that has attracted wide attention. Here, under the crowded conditions of a large city, with each teacher having thirty-five or more pupils, the principles and practices of the newer education have been demonstrated both within and without the classroom. For in this school, excursions and trips occupy a very important place. And every year over half of the pupils are taken into a rural environment during the month of June. Science receives a major emphasis in this school.

Miss Irwin and the Staff have a very definite philosophy regarding the education of children which they have put into effect. They apply the newer findings of psychology and psychiatry. The pupils are not a select group. They are taken in order of application from a long waiting list. The mental ability of the group is, however, slightly above that of the average New York City school. The pupils are grouped into classes on the basis of chronological age—the fours, the fives, the sixes—the thirteens. No marks are given, no gold stars, no records, no failures. Reading and writing are not taught until the child is seven years old and is in the second grade. Each group studies a particular general area each year, the sixes study their environment and Manhattan, the sevens study city housekeeping, the eights are Indians, at nine—the play's the thing, the tens study ancient civilizations, the elevens medieval history, the twelves American history, and the thirteens study the present. The ordinary tool subjects are all interwoven in the above general themes.

Members of the school have never had any difficulty upon advancing into the other schools and into high schools of New York City, where they have usually made excellent records. The discussions on the conduct of trips and excursions, the use of community resources, the creative arts, and the handling of problem children are interesting chapters.

Some very interesting material is included in the appendix, such as a list of trips, with brief comment, taken by the sixes; a discussion on skyscrapers by the sixes; six-year-old class record; science growing out of Indian Program based on eight-year-old interests; mathematical concepts for eight-year olds; three units of work followed by the thirteens in studying contemporary America. Daily schedules of each group; occupations of the parents; bibliographies used by teachers and by pupils; and samples of children's writings.

Written in good literary style, this book is challenging reading to all public school teachers, especially elementary teachers. *The Little Red School House* is an outstanding description of the theories of modern education as they are being worked out under crowded conditions in a large city. The results present a challenge to all elementary teachers everywhere.

—C.M.P.

DE LIMA, AGNES. *Democracy's High School.* New York: Bureau of Publications, Teachers College, 1941. 90 p. $0.90.

This is an account of experimental education in the Lincoln School of Teachers College, one of America's best known elementary and secondary schools. It is the story of living and learning in what is described as a "new kind of high school." Here has been worked out an integrated curriculum, characterized by a general course, described as an emerging program emphasizing constant growth and change.

The general course is organized about a central theme for the various grade levels. In the seventh grade it is "Man and His Environment"; in the eighth grade, "Early American Life"; in the ninth grade "Living in a Power Age"; in the tenth and eleventh grade "Ancient and Modern Cultures"; and in the twelfth grade "Youth in America Today." In addition to this general program there are electives such as mathematics, physical science, biology, and so on.

In addition to the above there are chapters on "General Resources and Activities," and "A Look Ahead." Included is a list of recent publications by members of the Lincoln School Staff.

—C.M.P.

DOANE, DONALD C. *The Needs of Youth.* New York: Bureau of Publications, Teachers College, 1942. 150 p. $2.10.

This is a doctoral dissertation based on the premise that for maximum effectiveness any desired learning should be directly related in the minds of the learner to his own welfare, his own interests, and his own needs. The more clearly learning is focused on such concerns, the more

efficient the learning will be. This study evaluates the commonly assumed needs of youth with respect to their adequacy as focal points for instruction or for organization of the curriculum. The study reviews representative statements and studies of youth's needs, problems, and concerns. The data for this study were obtained from an inventory study of 2,069 youth in Pittsburg, Pennsylvania, Oakland, California, rural Nebraska and rural Virginia. The inventory was divided into two parts, one phase of which related to science. In so far as boys' expressions are concerned, science comes well toward the top in popularity, but with girls science ranked third from the bottom.

The greatest concern to the total group was that of vocational choice and placement. Interest in this area definitely increased with age. In the last place among personal problems for both boys and girls were those in the area of religion and morals. Curriculum workers, supervisors and others concerned with the education of adolescents should be interested in this study. —C.M.P.

HURD, ARCHER WILLIS. *Study Guide and Textbook in Educational Psychology; Study Guide and Textbook in Technique of Teaching in Secondary Schools.* Minneapolis: Burgess Publishing Company, 1941. 134 p.; 88 p. $1.85; $1.50.

The study guide in educational psychology attempts to apply the principles of educational psychology to a college course in educational psychology. The unit-problem-project method has been selected as the fundamental concept about which to integrate the course. Units are as follows: (1) "A Survey of Topics, Textbooks, and Periodicals in Educational Psychology," (2) "Learning as Growth and Development in Personality and Behavior," (3) "Kinds of Learning," (4) "Factors Which Condition Learning," (5) "Organized Learning in School," (6) "Evaluation of Learning," and (7) "Philosophies of Learning and the Future in Educational Psychology." At the close is a bibliography and supplementary test exercises.

Technique of Teaching in Secondary Schools is a companion volume to *Educational Psychology* and is intended to follow it and apply the principles developed there. The organization of the two books is quite similar.

Both volumes continually keep in mind practical classroom problems and situations. Students in these courses will find the workbooks most useful, making the lectures and readings much more understandable. Classroom teachers on the job will find these two volumes both readable and applicable to their teaching problems.

The author is Professor of Education and Dean of Hamline College, and has long been noted for his researches in secondary education. In these volumes Dean Hurd has nicely balanced the experimental and the practical aspects of educational psychology. —C.M.P.

BRUNER, HERBERT B., EVANS, HUBERT M., HUTCHCRAFT, CECIL R., WEITING, C. MAURICE, AND WOOD, HUGH B. *What Our Schools Are Teaching.* New York: Bureau of Publications, Teachers College, 1941. 225 p. $2.75.

This is an analysis of the content of selected courses of study with special reference to science, social studies, and industrial arts. Comprehensive data are presented covering grades 4 through 12. Individual topics in these subjects are listed, and techniques are described for appraising topic significance. Curriculum trends are analyzed over a ten-year period, 1930–1940.

This study involved an enormous amount of work covering 85,000 courses of study, detailed and carefully constructed outlines of 1,175 selected courses of study. There were approximately 500,000 topic cards. Nine fields were covered, of which three are used in this report.

Chapter headings are as follows: (1) "Introduction," (2) "Techniques and Procedures," (3) "Analysis of Selected Courses of Study in Science," (4) "Analysis of Selected Courses of Study in Social Studies," (5) "Analysis of Courses of Study in Industrial Arts and Vocational Education," (6) "Some Suggestions and Conclusions Emerging From This Study."

A few of the conclusions relating to science courses of study: (1) Some attention is being given to the problem of sequence of science materials, especially in the junior high school, (2) Practically all courses of study in the intermediate grades and junior high school include considerable material from the fields of astronomy and earth science. This is not true in high school courses. (3) There is a tendency for materials in chemistry, physics, and biology to be less rigorously confined to these special fields. (4) The environmental approach is used extensively in junior high school. (5) Makers of courses of study are becoming more conscious of the needs and interests of students of science. (6) Consumer education is receiving little or no attention. (7) Lack of uniformity in organization and content seems to indicate that principles of organization and criteria for the selection of materials of instruction have not been formulated. (8) Some makers of courses of study are placing emphasis upon new ways of organizing materials. (9) All but two courses seem to have been worked out on the deductive basis.

The appendix contains two important addenda: (1) "Criteria for Evaluating Teaching and Learning Materials and Practices," and (2) "Some Principles for Establishing and Conducting a Curriculum Workshop-Laboratory."

Surely every pre-college science textbook writer, teachers of science methods and investigations in the teaching of science courses, as well as all science teachers interested at all in what other science teachers are doing, will heartily welcome this excellent contribution.

—C.M.P.

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